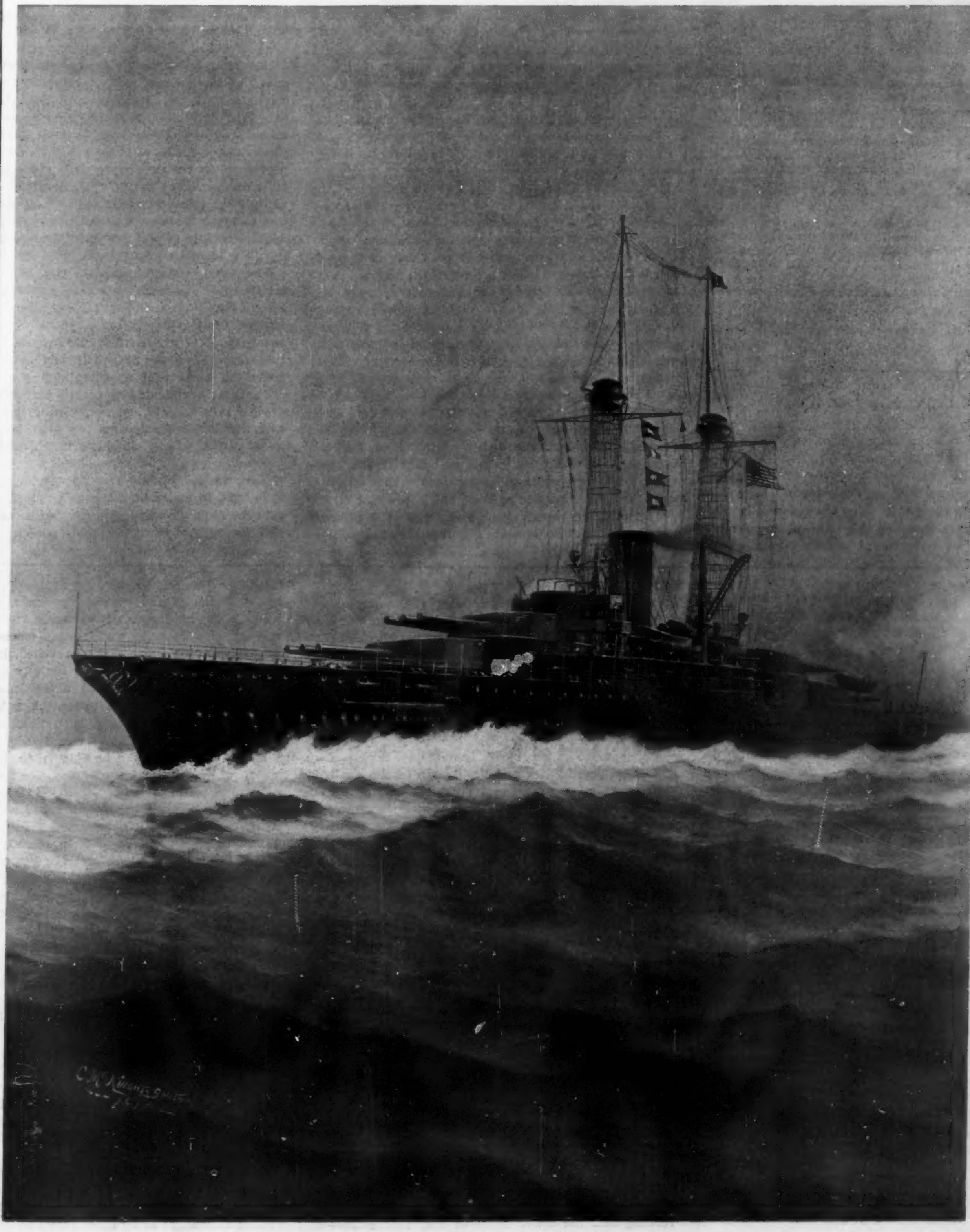
SCIENTIFIC AMERICAN



Displacement, 32,000 tons. **Length,** 624 feet on deck. **Beam,** 97 feet. **Speed,** 21 knots. **Guns:** Twelve 14-inch; twenty-two 5-inch. **Armor:** Belt, 14-inch; turrets, 18-inch. **Torpedo Tubes,** Four 21-inch. **Complement,** 1056.

OUR LATEST DREADNOUGHT "CALIFORNIA."—[See page 63.]

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp* the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

Target Practice in Our Navy

So frequently of late have alarming reports been published as to the deterioration of gunnery in our Navy, that we have been led to make a special investigation of this matter with a view to finding exactly how matters stand. That these reports have left an impression upon the public mind is suggested by the number of letters which reach this office asking for information as to the character of shooting done in our Navy to-day and its relative excellence as compared with that of foreign navies.

These are difficult questions to answer, mainly for the reason that the majority of the naval powers do not disclose the results of target practice. Even in the case of the British, the results given, for want of detailed information as to the conditions under which the trials are held, are not very illuminating. We know that the last published British elementary practice, that is, practice at short range, showed an improvement over previous years, and we know that they carry on about the same amount of battle practice as we do in our own Navy. The Germans have somewhat less battle practice, or practice at fighting ranges and under fighting conditions, than we have; and we know that the rest of the naval powers, because of the great expense presumably, engage in considerably less target practice than we do.

Is our gunnery better, equal to, or worse than that of, let us say, the British and the Germans? In answer to that we have to say that we simply do not know. Probably, because those two great naval powers are now at war, they are carrying on a large amount of practice under battle conditions, far more than they would in times of peace, and therefore we presume their shooting to-day is better, and possibly considerably better, than our own. But this is mere guesswork.

With regard to actual conditions in our own Navy, it may be said that while results at the target are far below what our ordnance officers could wish, the present conditions are not alarmingly bad. What is worrying our Navy Department is the fact that, whereas it is reasonable to look for a steady improvement in target practice, due to improved guns, better sighting and range-finding appliances, etc., it is no better, if as good, to-day as it was ten years ago, and the elementary practice held last fall was the poorest of any in the five years during which the present methods of carrying out target practice have been in use.

Of course, it must be taken into consideration that to-day the target is smaller, that the runs past the target are made, generally, in rougher water, and that, therefore, the test is more severe; but we are informed by officers who are enthusiastic in their endeavors to improve gunnery in our Navy that, even if allowance is made for these conditions, the results achieved are no better and, according to the opinion of some of them, not even as good as they were ten years ago.

As carried on to-day in our Navy, there are two kinds of target practice—the elementary and the battle practice. The elementary, which is held for the purpose of selecting gun-pointers, takes place at short ranges of from 1,600 to 1,800 yards. The target is moving and the ship opens fire at a range of about 1,800 yards, the range decreasing to a minimum of about 1,600 when the ship is directly opposite the target, and increasing thence gradually to 1,800 yards when the "cease fire" is sounded.

Battle practice is carried out under battle conditions. The ship is stripped for action; she approaches the target diagonally at a constantly changing range; and the corrections are made by spotting the fall of the shot from the fire-control platform. The minimum range for several years has been 9,000 yards, the ship being allowed to open fire at a greater range and receiving a proportionately higher mark for shots that get home at the greater distance; but the minimum range allowed was maintained at 9,000 yards, a reduction being made if the ship approached nearer. Ten to fifteen per cent of hits is considered good work under those conditions; but last fall, although the record was good, it should be noted that the average range for the ships that took part was 7,000 yards, and some ships steamed in to 6,000 yards; furthermore, the ships steamed parallel to the target, with the result that the change of range and the difficulty of keeping on the target were correspondingly smaller and the work of the gun-pointers was rendered more easy.

The lack of improvement and, in some cases, the positive deterioration in target practice, are to be attributed in large measure to the shortage of officers and to the fact that young and inexperienced officers have of late years been assigned positions on the fire-control platforms or in the turrets, which formerly were held by officers of greater age and longer experience. Thus, up to five years ago, a turret would be commanded by a lieutenant with a junior officer as assistant, whereas, to-day, due to the shortage of officers, many turrets are in charge of junior lieutenants or ensigns *without any assistants*.

One respect in which the Navy has been handicapped has been the breaking up of the Atlantic fleet into small units. The separation and isolation of ships lower that great spur to excellence—the spirit of competition. When the ship makes its individual run with the whole of the fleet as spectators (conditions which obtained when the Editor was present at battle practice on the Southern Drill Grounds some years ago) the presence of such a critical audience is a stimulus to everyone on the ship concerned—a stimulus which can never be present when the same ship goes out to make her run, solitary and unobserved.

The moral effect of immobilizing the Atlantic fleet off Vera Cruz for many months last year may or may not have been helpful to a solution of the Mexican difficulties; but its effect in breaking in upon the regular routine of target practice has, for the reason given above, been decidedly harmful, and the target practice records prove it.

Light on the Seamen's Bill

The possibilities and limitations of the construction, management and operation of modern sea craft make the problem of recreating our merchant marine one of great magnitude and complexity; but it is not insoluble, even by a nation most of whose legislators have been trained in an environment far removed from the sea. Until the enactment of the law of August 12th, 1912, all ships flying the American flag had to be built in American shipyards, where the cost of construction was from thirty to forty per cent greater than in other countries, with all that that involved in the way of earning dividends, providing for depreciation and covering by insurance on the excess cost. This disability alone had been sufficient to deter American shipowners from attempting to successfully compete against the foreign shipowner. By the act of 1912 and the extension of that act in 1914, Congress enabled the American to purchase anywhere a ship to be operated under the American flag in the over-seas trade. This was a step in the right direction, and despite other existing handicaps American shipowners fancied they could perceive the dawn of a new era in which they would have a fighting chance to show their mettle. But, alas, the same Congress that passed this statute suddenly introduced the Government Ship Purchase Bill. To compete against such handicaps as the lower cost of feeding and the lower rates of wages of officers and crews on foreign ships, with the larger number of licensed officers required on American ships, not to mention the expensive requirements of American administrative officials which are not demanded by foreign governments, would have taxed the ability of the American shipowner to the limit; but to compete against Government owned lines was asking too much.

At the end of the same Congress the so-called Seamen's Bill was passed. This bill embodies several radical innovations in maritime law, all of which had been submitted and several rejected at the International Conference on Safety of Life at Sea held in London from November 12th, 1913, to January 20th, 1914. The conference, which had been called at the suggestion of the Government of the United States, comprised representatives of the fourteen principal maritime nations of the world, and was composed of men trained to the sea and experienced in the administration of the laws relating to maritime affairs. Some of the provisions of this measure are fraught with menace and possibly irreparable injury to our domestic coast shipping, and particularly to our Great Lakes' steamers. No uniform set of inflexible rules can be devised to be made applicable to a shipping of such a diversified character as that of the United States without having such consequences.

The features of this bill, however, which are of most serious import and likely to be far-reaching in their effects, are those requiring that at least sixty-five per cent of the deck crew, exclusive of licensed officers, shall be certificated able seamen, that seventy-five per cent of the crews in all departments of the ship, deck, engine-room and steward, shall speak the language of the officers, and that the seamen shall have the right to demand half their wages at each port after five days' service. To obtain a certificate as able-seaman in the coastwise and deep-sea trade requires a preliminary service of three years on deck. The work performed by the deckhands on board a modern steamer, with her short masts, little rigging and almost no sails, is of the most ordinary kind of unskilled labor, and to insist that it requires three years' experience to acquire facility to perform such duties is absurd; capacity alone should be considered.

The other requirements of the bill in regard to certificated lifeboatmen, which are taken from the recommendations of the London Conference, amply provide for the safety of life without this additional requirement of certificated able-seamen. The effect of this feature of the bill will undoubtedly be to restrict the number of men available for crews. Moreover, these certificated men will naturally concentrate at the larger ports, where there is greater opportunity for employment, and few will be found at the lesser ports, where, should a number of these certificated able-seamen leave a ship, it would be difficult to replace them. Should this happen at a foreign port, it is hard to understand where a shipmaster would obtain the requisite number of men with these certificates, and as the ship could not leave port without her complement the embarrassment from such a state of affairs can be imagined in the case of a ship having a large number of passengers, or a highly perishable cargo, or mails aboard. Our laws provide that a licensed officer who, to the hindrance of commerce wrongfully or unreasonably refuses to perform his official duties shall have his license suspended or revoked, but there is no provision in the Seamen's Bill for any such penalty in the case of the certificated able-seaman. The only penalty incurred by the latter when he deserts his ship in violation of his shipping articles is that he shall forfeit his accrued wages, and the provision of the bill that a seaman shall be entitled to demand half his wages at the expiration of every five days is specially devised to minimize this.

The language requirements must of necessity militate against our trans-pacific steamers. Indeed, the Pacific Mail Steamship Company have already issued public notice of the withdrawal of their five steamers, which are among the largest at present under the American flag. These ships are obliged by law to carry American licensed officers, but their crews are largely Chinese. The petty officers among the crews understand English and are able, without any difficulty, to communicate the orders given them by the American officers. On no ships are the orders given by the officers to the seamen direct; it would be a physical impossibility on any large steamer to do so. To insist that seventy-five per cent of these Chinese shall speak English would prevent their being available in any department of an American ship. It will, therefore, be impossible to operate American ships in these trades on a paying basis in competition with the established Japanese lines which can easily comply with this requirement as the officers and crews are all Japanese. The difference in the wages cost would be insurmountable. The contention that the provision of this bill permitting foreign steamers to desert their ships and violate their contracts with impunity while in American ports will be taken advantage of by these crews to demand the higher wages prevailing at American ports, and thus the cost of operation on all vessels will eventually be equalized, fails to take into account that these crews would be liable to imprisonment upon their return to their native country, and, in the case of the Japanese that by virtue of the convention between Japan and the United States the Japanese seaman is not granted a passport to enter the United States. The ultimate result will undoubtedly be to turn the entire trans-pacific traffic over to the Japanese and eventually the traffic from the Atlantic American ports to the Orient *via* the Panama Canal.

Astronomy

Winnecke's Comet, which was last previously visible in 1909–10, has returned very nearly according to calculation, having been found by H. Thiele, with the great reflector of the Hamburg Observatory on April 4. It was then in Leo Minor, and of the 16th magnitude. It is due to reach perihelion September 1.

Earliest Visibility of the New Moon.—A Pittsfield, Mass., correspondent of *Popular Astronomy* writes that he was able to find the new moon with field glasses and then glimpsed it with the naked eye at 7:44 p. m., May 14, when its age was only 21 hours and 13 minutes. Can anyone beat this record (leaving solar eclipses out of consideration)?

Rotation of the Solar Corona.—Photographs of spectra of the east and west portions of the sun's corona, obtained at Strömsund during the eclipse of last August by Messrs. Bosler and Bloch, of Meudon Observatory, appear to show that the corona rotates in the same direction as the surface of the sun and more rapidly. A comparison of the displacements of the spectrum lines indicates an equatorial velocity of about 3.9 kilometers per second.

Miss Anna Caroline Brooks, daughter of Dr. William R. Brooks, director of Smith Observatory, Geneva, N. Y., on the evening of June 25th, observed a very brilliant object, equaling Venus, just over the sunset point about ten minutes after sunset. It was seen for about two minutes, when it was obscured by a narrow cloud. Search on the next evening failed to reveal the object. Dr. Brooks is of the opinion that this object was the nucleus of a very brilliant comet, the tail of which was rendered invisible by the bright sky so near the sun.

Did Copernicus Ever See Mercury?—One of the stereotyped statements in works on astronomy is that Copernicus was never able to catch a glimpse of Mercury; a planet which, at greatest elongation, is easily observed with the naked eye in all parts of the United States, but is by no means so easy to observe in northern Europe. The *Journal* of the Royal Astronomical Society of Canada quotes extracts from many astronomical writers, including Copernicus himself, the net result of which is to leave us in the vale of uncertainty as to whether this illustrious astronomer did or did not ever behold the planet in question.

The Variability of Mira, or Omicron Ceti, which, with the probable exception of Algol, is the best known of all variable stars, has been the subject of some recent observations which are summarized in *Nature.* The variability of this star is quite irregular, both as to period and as to the maximum and minimum magnitudes attained. At its last maximum, which occurred last January, it reached a magnitude of only 4.2, while the maxima in 1910, 1911 and 1914 were 3.3, 3.5 and 3.6, respectively. At its brightest maxima its magnitude has been estimated as high as 1.2. Its minima range from 8.0 to 9.5. It is suggested that these minor changes are themselves periodic.

The New Draper Catalogue of Stellar Spectra which has been in preparation since 1911 at the Harvard College Conservatory under the direction of Miss Annie J. Cannon, is approaching completion. In the middle of April Miss Cannon reported that the observations for the catalogue would probably be finished in six months, and that printing might be started soon after that time. This immense work, which will include the spectra of about 200,000 stars, has been described as the largest astronomical undertaking hitherto carried out almost wholly by women. Up to April 17, the number of spectra classified was 199,196. About 150,000 of these had been identified, the facts being copied on cards, which are filed in order of right ascension, where they may be readily consulted. The spectra of more than 8,000 stars have been sent to astronomers in the Old and New Worlds for use in various investigations.

The "Tricolor" Star.—Patriotic enthusiasm, now at a high pitch in France, has been seeing in the heavens things which it likes to regard as symbolical of French victory in the war. The most talked of "omen" has been a tricolored star seen over the western horizon last autumn and over the eastern during the winter. Prosaic astronomers have unkindly identified this marvelous star with Venus, which, like any other heavenly body, shows the spectral colors when it is near the horizon. It is remarkable how often Venus has been taken for something that it is not. One would think that no civilized human being could arrive at years of discretion without becoming well acquainted with that lovely planet under her own name, yet her brilliant light in the evening or morning sky is forever starting some wild rumor. In 1797—also a time of patriotic fervor—Venus was hailed in France as the star of Napoleon. In recent years she has most frequently been taken for the light of a spying Zeppelin or aeroplane. It may be added that in some parts of France the "tricolor" star of the last few months was not Venus, but Sirius.

Science

A Recrudescence of the Daylight-saving Fallacy is reported from Canada by the American consul-general at Halifax. According to his report, meetings are being held all over the Dominion with a view to bringing to the attention of the federal parliament the alleged desirability of setting clocks back one hour on April 1st of each year, continuing to some autumn month, "in order to give more daylight for work or pleasure." Of all dates that might be selected for perpetrating such a piece of arrant nonsense, April 1st is undoubtedly the most appropriate, in view of the traditional associations of that day.

Why is Glue Sold in the Dry State?—The drying of glue is the most difficult and delicate operation in its manufacture. The dried glue retains a variable percentage of water, and it must be soaked for a considerable time before it can be used. Prof. Wilhelm Ostwald has suggested that it would be far better to sell glue in the form of a jelly of definite water content, which could be kept for any length of time in open vessels by the addition of a small quantity of a suitable antiseptic, such as beta-naphthol, and could be made ready for use quickly by heating.

Color Variations of the Black Bear.—Studies made at the American Museum of Natural History show that the so-called blue or glacier bear, formerly classified as a distinct species under the name of *Ursus Emmonsi*, and confined to a limited region near the St. Elias range in Alaska, is only a color phase of the black bear (*Ursus Americanus*). The black bear has a number of other well-marked color phases, some of them very local. Thus the white bear, formerly called *Ursus Kermodei*, is apparently one of these variants; while the cinnamon bear is a well-known color phase of the same species.

Blood Bread.—Prof. Kober of Munich has published a little treatise on the utilization of blood as food, from which *Die Umschau* quotes the following statements concerning the use of blood in breadmaking. For centuries blood bread has been the staff of life of the Esthonians of the Baltic provinces and their colonies in all parts of Russia. It is made of rye flour, with an admixture of at least 10 per cent of whipped hogs' blood. In the vicinity of Petrograd ox blood is also used. Blood bread is very nutritious and is highly praised by Esthonian physicians because of its richness in organic compounds of phosphorus and nerve-restoring salts. Bread made with ox blood dries very quickly, but this defect can be remedied by the addition of potato flour, which is now a common practice in Germany. Blood bread is the most natural substitute for meat and, with government control of the slaughter houses, it need cost little or no more than ordinary bread. According to the *Frankfurter Zeitung*, rye bread containing hogs' blood has long been used in Oldenburg.

An Interesting Solar Halo was observed at several points in the eastern United States on May 20th. As seen at Philadelphia and very generally in eastern Pennsylvania and New Jersey, the halo included, in addition to the ordinary heliocentric circles of 22 degrees and 46 degrees radius the parhelic and a pair of oblique arcs of the anthelion. At some points the rare anthelion itself was visible. As usual, this halo has been described in scientific journals, and *à fortiori* in the daily newspapers, with the circumlocution which results from ignoring the well-established nomenclature of halo phenomena. A botanist who wishes to record the occurrence in some locality of *Bellis perennis* does not waste words in repeating the descriptions of this plant found in standard manuals of botany. On the other hand, the occurrence of almost any optical phenomenon of the atmosphere is commonly reported with little or no regard to the existing body of knowledge on the subject.

The Mortality of Waterfowl Near Great Salt Lake has attracted widespread interest in recent years, and there have been many speculations as to its cause. Thousands upon thousands of wild ducks, snipe, sandpipers and other birds have perished, and the situation is of more than local importance, as immense numbers of birds stop in this region while migrating and many of them succumb to the prevailing malady. A similar mortality has been reported at Tulare and Owens Lakes in California, and probably occurs at many other points in the west. This matter has recently been investigated by the U. S. Biological Survey, which finds that in all probability the trouble is due to an alkaline poison. The birds probably sicken in the shallow water bordering the mud flats. As these flats dry after high water, salts and alkalies crystallize on the surface of the ground. Later pools from rain, or a steady wind blows the water over the flats; the highly soluble salts are taken up by the water; and birds feeding in the water thus charged are poisoned. Concentration of the salts by evaporation in poorly drained pools leads to the same result. Measures for keeping the water fresh are the only remedy thus far indicated.

Automobile

100 Hours Free Service!—A novel type of free service plan has just been started by one of the large motor companies of Detroit. Every purchaser of a car made by this company will receive hereafter a coupon book with his car, entitling him to an hour's free repair and overhauling for each coupon. The book contains one hundred coupons, good for one hundred hours. The coupons will be accepted by any dealer or service station handling this car.

Eight-Cylinder Knight Motors.—The Knight sleeve-valve motor is to be produced in eight-cylinder V-type form this year, and to be embodied in a car selling at $1,095. The peculiar advantages and also the mechanical difficulties of a sleeve valve engine are said to have been fully taken into consideration in this new motor, and from the standpoint of the automobile engineer it is doubtful if any other development in the industry in this stirring year 1915, approaches the new motor in interest. Not even the remarkable Twin-Six motors, of which five are already on the market, have created as much interest and speculation as the Knight-engined "Eight." Its work is destined to be watched with the greatest of attention.

New British Pump Keeps Tire Hard.—A tire pump that not only pumps up any tire within a few minutes, but that keeps the tire at that pressure regardless of punctures, is a British invention. The pump can be attached to the hub of the wheel in less than a minute by any person. It works on the rotary pump principle, each revolution of the wheel, while running the car, driving air into the tire, and so effective has this device shown itself during a recent official test by the Royal Automobile Club of Great Britain, that a tire, deliberately punctured in five places, was kept at full pressure as long as the car was kept running. The device appears to have solved the roadside repair problem. No car need stop because of a puncture if fitted with one of these pumps, as it can be run with ease and without danger to the nearest garage or repair shop.

The Headlight Glare Problem.—Realizing the extreme importance of the glaring headlight problem, which has caused much anxiety, adverse legislation and ill feeling, the Society of Automobile Engineers has officially recognized it as demanding immediate attention. A series of tests have been worked out which may be used as a standard definition of what constitutes a dangerous "glare," and the results of such tests will be submitted to manufacturers of headlights, with a view to diminishing the "glare"—which is something quite different from the strength of the light itself, headlights of comparatively low candle-power and short distance efficiency, yet are abnormally glaring to the eye of the observer stationed somewhere in front of the automobile. Future headlights are to be constructed according to scientific formulæ, eliminating the glare but thoroughly retaining the far-reaching effects of a searchlight upon the road itself.

American Has Turtle-Back Armored Car.—A novel type of armored motor car has been designed by a resident of Lowell, Mass., which contains some very original ideas as to protection from rifle and gun fire. The car is shaped exactly like a turtle, the upper and lower shell being joined at a distance of about sixteen inches above the ground. The wheels are almost entirely covered by the armor. The latter is composed of steel shells, curved to represent a turtle-back, the inventor claiming that such a construction renders the persons in the car immune from rifle and machine gun fire, as the bullets are deflected into the air. Loopholes for firing, a periscope for steering, emergency doors in the rear and on both sides, a powerful motor under the driver's seat, and a quick-firing gun mounted on a revolving base—these are all parts of the design.

Production Plans for 1916.—Although the year 1915, in the automobile business sense, has been the most wonderful in the history of the industry, next year promises to eclipse it entirely. The manufacturing plans of all the large companies have been completed, orders for parts and accessories have been placed and a fair estimate can now be made of the number of new cars to be turned out next season. In this compilation twenty companies are listed under letters of the alphabet separately, the remainder being grouped in their entirety. The figures are based on knowledge of parts and materials ordered, and not on the "estimates" given by the companies themselves. A, 500,000; B, 100,000; C, 80,000; D, 75,000; E, 60,000; F, 40,000; G, H, I, J, K, 25,000 each; L, M, N, O, 20,000 each; P, Q, R, S, T, 10,000 each; the remaining eighty-odd companies turning out less than 75,000 cars together. The total number for 1916, therefore, will be in excess of one million new cars! That the country will be able to absorb them is a certainty.

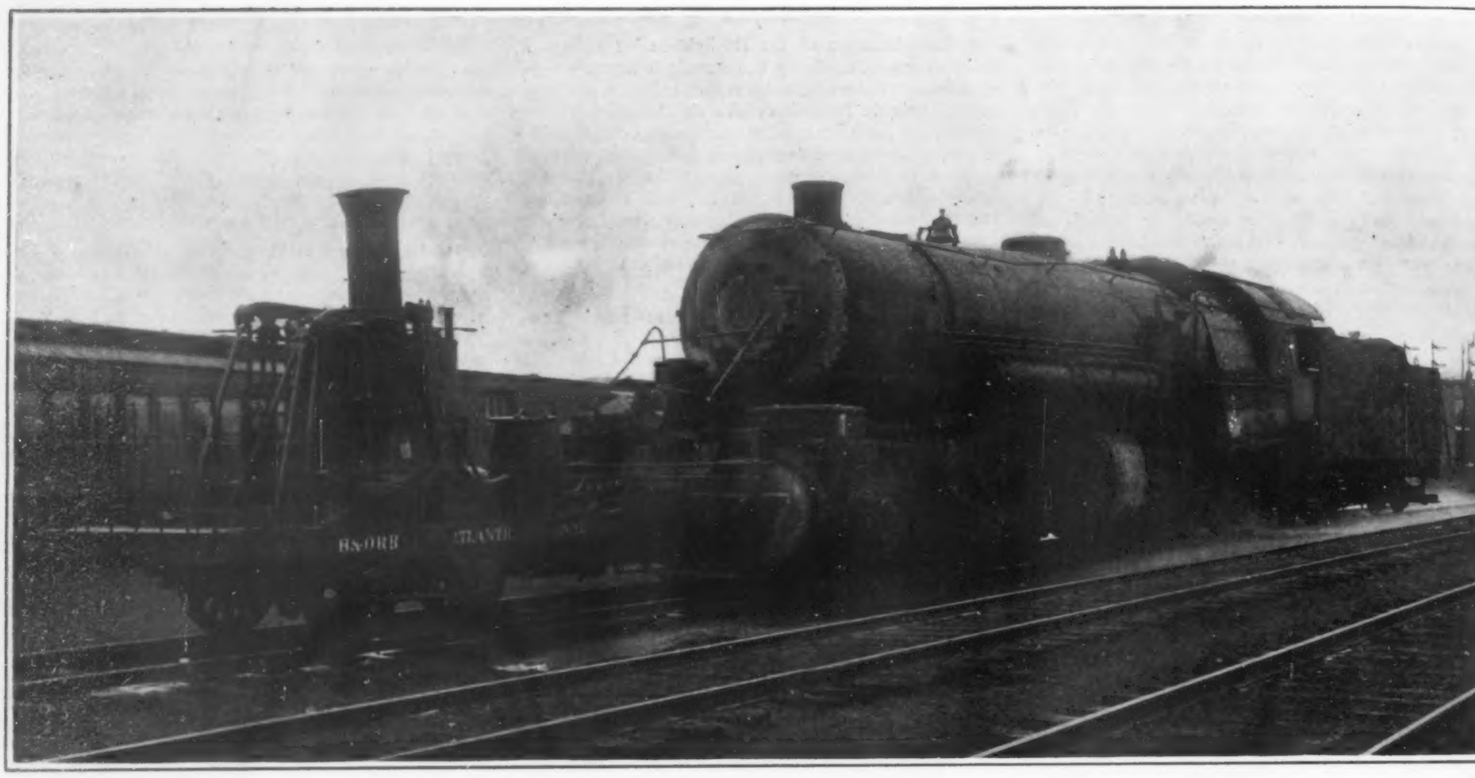


Fig. 1.—The original "grasshopper" locomotive, with a modern freight engine: Baltimore & Ohio Railroad. 1832-1911.

A Contrast in Locomotive Practice

An Engine of To-day and One of Eighty Years Ago

By Herbert T. Walker

AN almost forgotten page of locomotive history will be recalled by the accompanying engravings, the first of which shows two locomotive engines together, one built in 1831-32, the other in 1911.

They differ so widely in design and construction that one might doubt whether the earlier example, the "Atlantic," was intended for the same class of work as its gigantic companion, No. 2415. Nevertheless, such is the fact.

The "Atlantic" was built by Davis & Gartner of York, Pa., and was placed in service on the Baltimore & Ohio Railroad in 1832. As will be seen, the boiler is vertical, as are also the cylinders, the piston rods of which are connected to vibrating beams, transmitting power to the driving wheels by means of cranks on an independent shaft, which is geared to the driving wheel axle by a spur wheel and pinion, so proportioned that the driving wheels make two revolutions to one of the independent crankshaft.

Only one pair of wheels was used as drivers, which are 3 feet in diameter. The cylinders are 10 inches in diameter with a stroke of 20 inches. The boiler is 51 inches in diameter and 60 inches high. The engine originally weighed 6½ tons with fuel and water. It gave much trouble at first, for the gear wheels wore irregularly and broke often, owing to the vertical play of the driving wheels in the pedestal jaws.

Nevertheless, with all its defects it drew a load of 18 tons at an average speed of 12 miles an hour; but on several occasions it hauled 30 tons from Ellicott Mills to Baltimore, a distance of 13 miles, within an hour. Running with its tender only the "Atlantic" has attained a speed of over 30 miles an hour.

Other details are of interest. The boiler is multitubular and the fuel was anthracite coal. The exhaust steam drove a fan for urging the fire, and some of these engines retained this device for many years in spite of the fact that the steam blast pipe was in use on British locomotives as far back as 1805. The "Atlantic" and other engines of its class are known as of the "Grasshopper" type, owing to the resemblance of the beams and connecting rods—especially when in action—to the hind legs of that insect.

To prevent the breakage of gear wheels, as previously alluded to, later engines of this class had a separate countershaft for the spur wheel and connecting rod cranks, and a second countershaft and pinion provided with outside cranks coupled by short rods to cranks on the driving axles, which were also coupled together. An engine of this improved form is shown in our second illustration. With this arrangement the two countershafts were securely held in their bearings and the vertical play of the driving wheel axle put no undue strain upon them. The gearing ratio of two to one was retained, and between 1832 and 1837 about 20 of these engines were built, one or two of them for foreign railroads. Several of them remained in service for over 50 years, and the "Atlantic" is still in the possession of the Baltimore & Ohio Railroad.

Fig. 2.—An improved "grasshopper" engine. Baltimore & Ohio Railroad. 1833.

In view of the fact that in the year 1829 George and Robert Stephenson had built their "Rocket" engine for the Liverpool & Manchester Railway and that this engine embodied all the essential features of the modern locomotive, it appears singular that such an outlandish design as the "Grasshoppers" found so much favor; but the reason they were used on the Baltimore & Ohio Railroad was the unusually light strap rails and sharp curves prevailing on that line as originally built. Some of the curves at the street corners had a radius of only 60 feet, hence a short wheel-base was imperative, which necessitated the upright boiler. This in turn had to be kept as low as possible to prevent the engine from being top-heavy, which could only be done by employing small wheels. These were geared two to one, so that the piston velocity was low in proportion to the speed of the driving wheels; for it is obvious that the clumsy grasshopper beams could not run fast without making the engine unsteady, besides racking the boiler to which they were fulcrumed.

Turning now to the Mallet compound articulated locomotive, which is one of several of its class built by the American Locomotive Company, we are impressed with its dimensions; for the low-pressure cylinders (at the front end of the engine) are 41 inches in diameter—only 10 inches less than that of the boiler of its predecessor. In the matter of length also we find that the modern engine has a wheel base of over ten times that of its companion. Its weight is 231 tons and the total heating surface amounts to 5,540 square feet. Its tractive effort, when working compound is 105,000 pounds, but when working simple it reaches 126,000 pounds. This enables the engine to haul loads of 1,500 tons on 2½ per cent grades over curves of 9 to 12 degrees, which is a very creditable performance.

A comparative table of dimensions of the two engines is here appended, giving a good idea of the great progress made in locomotive practice during the past eighty years.

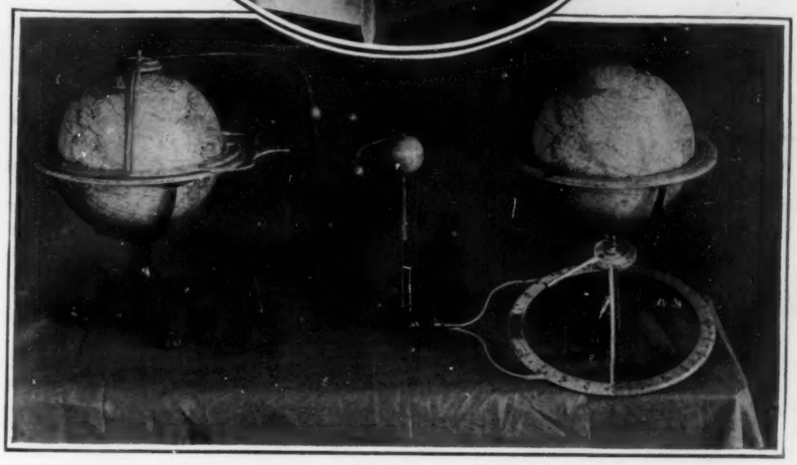
The writer's thanks are due to Mr. F. H. Clark, General Superintendent of Motive Power of the Baltimore & Ohio Railroad, for his courtesy in furnishing the interesting particulars embodied in the present article.

Engine	Cylinders		Driving Wheels	Total Wheel Base	Boiler		Weight in Working Order	Maximum Tractive Power	Average Load
	Diameter	Stroke	Diameter		Diameter	Pressure			
Atlantic	10 in.	20 in.	36 in.	4 ft. 0 in.	51 in.	50 lbs.	6½ tons	1,500 lbs. (Approxi.)	24 tons
2415	H. P. 26 in. L. P. 41 in.	32 in.	56 in.	40 ft. 8 in.	89¾ in.	210 lbs.	231 tons	126,000 lbs	1,500 tons

Using Explosive Gas Burners Under Water.—Explosive gas burners have been successfully used in recent experiments for the autogenic cutting of metal under water. According to the *Zeitschrift für Sauerstoff- und Stickstoffindustrie* the process is very simple. It is only necessary to screw over the point of the burner a bell-shaped hood into which compressed air is led during the cutting. The water is thus forced away from the mouth of the burner, so that the flame can burn freely. It is said that successful experiments with this new burner have been conducted at Kiel. Among others, a diver working at a depth of 5 meters cut through a square piece of iron with an edge 60 millimeters long in 30 seconds.

Celestial Globe and Tellurian

In order to give school children a graphic demonstration of the elements of astronomy, the apparatus pictured in the accompanying engraving was invented. It is arranged to explain clearly and with considerable accuracy the following astronomical phenomena: Day and night; morning and evening; sunrise and sunset; civil and astronomical time; the four seasons of the year; the equinoxes and solstices; the phases of the moon; Mercury and Venus as the morning and evening stars: the tides; latitude and longitude; the solar day; sidereal, tropical and leap years; the sun's perihelion and aphelion; the sun's semi-diameter and constellation; the sun's declination for every day of the year, and its right ascension, not only for every day, but every hour and minute of the day: the moon's declination, apogee and perigee; the moon's librations in latitude and in longitude; the moon's surface; the equation of time; the right ascension of the mean sun; right ascension of the true sun; the earth's meridians and parallels of latitude; the isothermal lines for January and July; oceans, seas, lakes, countries and cities.



Geographical globe with attachments to demonstrate the elements of astronomy.

The globe is accompanied by a chart, and by the proper shifting of an overlying transparent disk, shows the exact location and configuration of the heavenly constellations with reference to any point on the earth's surface at any time. The chart gives the names of the planets and their satellites, together with their mean distance, sidereal period, orbit velocity and mean diameter as well as the magnitude of the stars. The apparatus consists of a geographical globe with the usual horizon circle, over which is placed another circle that shows a division of civil time A. M. and P. M., also the astronomical division of time; morning, noon, evening and midnight; the moon's age and mean right ascension. This circle does not completely cover the horizon circle and the extended portion of the latter is marked with sidereal time, showing right ascension or the division of the heavens. The night section of the overlying circle is shaded to represent darkness and the junctions of the night and day sections are connected by a meridian circle passing over the top of the globe and there supporting two disks, one of which is in fixed position and the other movable. Connected to the latter is a rod on which is affixed a small sphere representing the moon. Secured to the moon is a slightly conical cylinder which may be adjusted to represent the shadow of the moon. In conjunction with this globe on a separate stand is a sphere representing the sun, and connected therewith, but movable about the axis of the sun, two small spheres representing the planets Mercury and Venus. In use, the sun would be placed at a convenient distance from the globe and a handle on the overlying circle of the globe, representing the direct ray of the sun, would be pointed at the sun.

An endless number of experiments can be made with this apparatus, and the following is given merely as an example. Suppose that it is desired to find the position of the constellations for any date or any latitude. First turn the overlying disk until the handle representing the direct ray of the sun points to the day and month desired as indicated on the index circle. Find on the overlying circle the hour and minute of the day sought, and read the sidereal time shown on the extended portion of the horizon circle below.

Next, place the transparent disk upon the star chart, which accompanies the globe, so that the latitude of the place for which the observation is being made as shown on the transparent disk, is directly over the center of the star chart. Then rotate the transparent disk, always maintaining the latitude of observation directly above the center of the star chart, until the meridian line on the transparent disk passes through that point on the rim of the star chart which indicates the same sidereal time as that previously found on the celestial globe.

If the observer now faces the south and holds up the star chart and transparent disk in the same relative positions just found, he will find that all the stars and constellations on the star chart will occupy the same relative position to the observer as the actual constellations do at the time desired. The point on the star chart directly beneath the point marked "Zenith" on the transparent disk will be found to indicate the exact configuration of the heavens for the point directly above or in the Zenith for the latitude and time sought, while the rim of the transparent disk is directly over the constellations which are on the horizon of the observer.

Effect of Pressure on the Diver

In diving to locate the sunken submarine "F-4," outside of Honolulu harbor, Chief Gunner's Mate Frank Crilley of the United States Navy broke all deep-submergence records by going down to a depth of 288 feet.

The public has been amazed by this performance, and has naturally wondered how the human body could withstand the enormous pressure of the enveloping water at that depth. However, that record does not outstrip the possibilities of our physical endurance. No less an authority than Prof. J. S. Haldane, M.D., F.R.S., has declared, "It would seem probable that a man supplied with air in the usual way might dive to about four hundred feet!" Why, then, is it that so many under-water workers have heretofore lost their lives through asphyxiation, paralysis, etc., after dives at much more modest depths and following their return to the surface in apparently sound conditions? In answering this we shall tell how Crilley and his mates have done the work they have, and, at the same time, we shall acknowledge our indebtedness to that committee, instituted by the British Admiralty some years ago, which blazed the way to our present fuller understanding of the physiological circumstances involved in pressure work, whether it be that of the diver or the sand hog in the caisson. The human body is decidedly complex and all parts of it are not reached by the arterial circulation in the same period of time. The capillaries carry the blood much more slowly than do the active arteries of the main circulation, and, again, the tissues fed by the capillaries take up the blood at a still more sluggish rate. Reversing this process, the blood that has reached the tissues returns to the venous ebb of the main circulation last, and this may mean a lag of an hour or more under some conditions. Let us see what is the possible outcome of this tardiness.

When a diver breathes air under pressure, the blood in the cells of the lungs absorbs the air under that pressure—both the oxygen and the nitrogen—and the arteries carry it into the body. The longer the man is under pressure the farther the absorbed gases will be carried into the system by the stages we have already described. The higher the pressure the more serious this becomes as the body reaches general saturation. Now a considerable part of the oxygen undergoes a chemical change through its action upon the body substance, but not so with the nitrogen, and all that is absorbed in the system must again pass out by the circulation in such fashion that the gas shall not have a chance to produce bubbles. The deeper the nitrogen, carrying with it its initial pressure, penetrates the tissues the longer the time required to make sure of its retreat in its soluble union with the blood.

If nitrogen bubbles form through a diver's sudden ascent or decompression, and those bubbles press upon nerve centers or grow in volume enough to choke the heart and thus block the normal life stream, then paralysis or death, as the case may be, will follow. While the general circulation will quickly adjust itself to lessened pressure, the capillaries and the outlying tissues are much more tardy, and the welfare of the diver hinges entirely upon the time devoted to his decompression. But the British investigators established, among other things, this fact of prime practical importance—something of the utmost commercial value. No matter how deep the diver had gone or the length of time of his stay on the bottom, it was perfectly safe to bring him up quickly, at the rate of a foot a second, to a depth corresponding to half of the total absolute pressure to which he had been subjected. For instance, if he had been down to a depth of 175 feet, with a hydrostatic pressure of 75 pounds and an atmospheric pressure of 15 pounds, making a total of 90 pounds, it would be perfectly proper to bring him up to a point where the combined pressures did not exceed 45 pounds, or let us say, 70 feet below the surface. This sudden rise of 105 feet would still insure against the formation of nitrogen bubbles in the body, while it would get

(Concluded on page 69.)

Experimental compression chamber used by the British Admiralty Committee.

Photo-micrograph of spinal cord of goat killed by sudden decompression.

Goat's mesentery, showing nitrogen bubbles caused by rapid decompression.

The Strategic Moves of the War

By Our Military Expert—July 7th, 1915

During the week ending July 7th the fighting on the numerous battle fronts did not differ materially in character from that which occurred in the previous seven weeks. In the French, Italian, and Turkish theaters there were no marked changes in the situation, but kaleidoscopic changes continued in the German campaign against Russia on the eastern battle line, and the future developments of the great war depend as much as ever on the outcome of this campaign, which is the supreme effort up to date of the German armies.

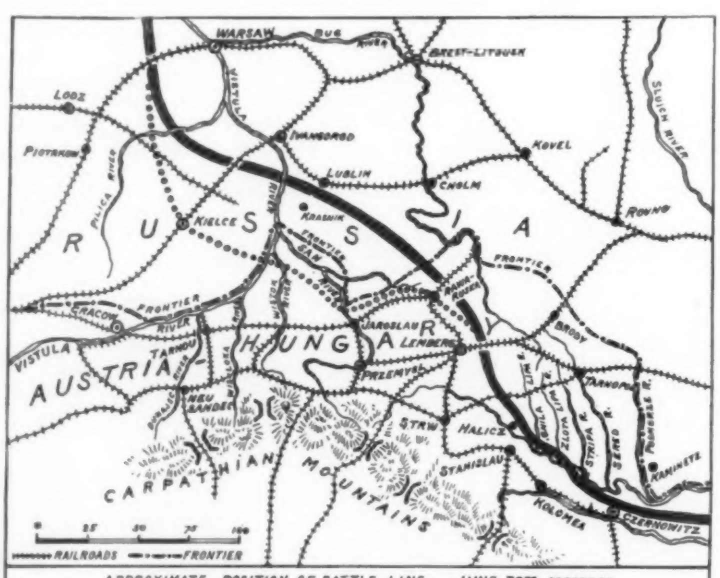
The general disposition of all the contending forces makes this an opportune occasion to recall very briefly the large strategic situation which has confronted Teutons and Allies from the outset and has controlled the initiative of both sides. Germany and Austria-Hungary occupy a central position in Europe and lie side by side. Intercommunication is easy naturally and has been greatly facilitated by the system of strategic railways constructed in both countries by way of preparing for this war. Co-operation between their armies and the rapid concentration of the bulk of their forces on any one of the three principal battle fronts—Russian, French, and Italian—are controlling factors in the formation of every German strategic plan, enhanced in importance because of the unfavorable geographical position of their enemies. Intercommunication between the Allies is much more difficult, and is almost impossible between the eastern and western fronts. If Russia, England, France, and Italy could join hands and operate on a united front, the Germanic forces would surely be overwhelmed by the weight of numbers and steel, despite their wonderful civil and military organization and superior leadership. But this is not possible, and the Russian flag will not dip in salute to the flags of the other allied nations until Germany is prostrate.

From the beginning of the war every German campaign has been planned to get the maximum benefit from the central position of the Germanic nations. In few words, the controlling idea of German strategy has been to concentrate on but one front at a time for the most powerful offensive possible while conducting an active defensive on other fronts with the weakest possible forces. They are attempting with millions of men and practically all Europe for a battlefield what Napoleon repeatedly did a hundred years ago with hundreds of thousands in much more restricted areas. Napoleon would outmaneuver his enemies until their armies were separated and beyond supporting distance of each other and would then destroy them in detail, thus frequently winning campaigns with inferior numbers. Germany is fortunate in not having to resort to skill to separate her enemies, since the geography of Europe has accomplished for her what would otherwise be a most difficult task; but we must admit that she has met with much success in her preliminary efforts at the still more difficult task of destroying in detail the vast armies that have been brought against her.

As has been said before in these articles, the decision that would most speedily terminate the war in Germany's favor is to be sought on the western battle front, and the German pre-war plan was to seek and, if possible, reach this decision in a sudden campaign that would overwhelm France before Russia could do much harm in the east. She failed to do this and was compelled to turn the bulk of the Teuton forces against Russia. There are many reasons for concluding that the original plan has been abandoned only temporarily, but the developments of succeeding weeks in Russia bring increased doubt as to Germany's ability to resume it in the near future, if at all, in sufficient force to insure success.

For a time the great German drive into Galicia promised so to weaken and demoralize the Russian army as to permit Germany to withdraw a million or more men from this front and shift them to some point on the western front. Such a force suddenly thrown into the fight in France with artillery support and the disregard for life that have characterized German attacks at decisive points might well overwhelm the allied French and English and decide the western campaign. But the probability of the Teutons being able to do this grows less and less as time goes on without a decisive defeat of the Russians, and our regard for the crafty skill, strategic ability and sound leadership of the Russian commander grows apace. More than two months have elapsed since the beginning of the present Russian campaign, and many times during that period the Teutons have seemed to be on the point of effectually dividing the Russian forces; but on every such occasion our morning papers have told us that the wily Russian has eluded this catastrophe and is withdrawing to a new position, where he can repeat his dangerous but apparently necessary tactics. The Teutons have overrun much territory, taken many prisoners and captured much booty, but the Russian army is still intact with a vast unconquered territory behind it, and the Teutons are apparently no nearer a decisive decision than they were some weeks ago. But there is no falling off in the vigor of their campaign and they appear to be as determined as was Grant to fight it out on the lines they have chosen regardless of the time it may take.

The last effort to break the Russian line, begun during the week under consideration, is being directed against the portion of the line which ran almost east and west between Kielce and Rawa-Ruska. This was the position of the battle front June 30th, and is shown on the map. After the capture of Lemberg in the latter part of June one German army (Gen. von Boehm-Ermoli) followed the Russians to the east of that city; on its right was another (Gen. von Linsingen) co-operating with a third (Gen. Pflanger) still farther south in an effort to drive the Russians across the Dniester. Field Marshal von Mackensen's army was about Rawa-Ruska and to the west, where it joined hands with the army of Archduke Josef Ferdinand in the region of the junction of the San and Vistula rivers. To the west of the Vistula on the line running north to the Baltic were the forces that have been holding this section of the line throughout the campaign. In all there probably are more than two million men on the entire battle front, by far the larger part being east of the Vistula. The most spectacular moves throughout the entire campaign have been by the army under Field Marshal von Mackensen, and again it was in the favored position. It might push on to the east, break the line in its front, then swing to the southeast before the Russians on the Dniester could escape, and effectually cut off this large portion of the Russian army. Or it might advance north in conjunction with the forces of Archduke Josef Ferdinand against the east and west portion of the battle front in an effort to break the Russian line in this sector. The latter plan was chosen, probably because it offered as good chances as the first plan for driving a wedge through the Russian line, and, in addition, it would strike at the rear of Warsaw—a prize the Germans have sought since the opening days of the war.



Advance of Austro-German drive from June 30th to July 7th.

This new advance has succeeded in pushing the Russians to the north, but has been as unsuccessful as all previous efforts to cut the Russian army in twain, and if we may judge by previous performances of that army, it will make any sacrifice of valuable territory and important cities rather than permit such an outcome for the campaign. And important sacrifices will probably be necessary, for a continuation of the German advance will eventually stretch the Russian line to the breaking point, if it should attempt to remain indefinitely to the west of Warsaw and the Vistula River. Either the German advance must be checked or the Russian line must be straightened out by the abandonment of Warsaw and the territory west of the Vistula, or by the abandonment of the line of the Dniester and with it the balance of Galicia.

The line selected for an advance on Warsaw is the same as that selected by the Austrian General Staff prior to the war, and followed by the Austrian army in its first advance into Russia in the opening weeks of August of last year, when an effort was made to capture Warsaw before the Russians could mobilize. But the Austrians met stronger forces than they expected, were defeated south of Lublin and driven back into Galicia, and finally to the south of the Carpathian Mountains to the positions they occupied when this campaign began two months ago. There seems to be but a small chance that this bit of the history of the war will be repeated. On the contrary, Warsaw, the unreached goal of many hard-fought campaigns, appears to be doomed.

But there is much hard fighting ahead of the Germans before the city is abandoned; for it is protected on the south by the strongly intrenched camp of Ivangorod and the fortress of Brest-Litovsk one hundred and fifty miles to the west. They will form strong supporting points for the Russian army, but need not necessarily be captured by the Germans before the fall of Warsaw. Just as the Russians surrounded Przemysl and passed it by in their advance into Galicia last October, so the Germans may surround Ivangorod and press on to Warsaw, protecting themselves from attack from Brest-Litovsk. A successful bombardment of Ivangorod without railways to transport the vast quantities of ammunition would be a stupendous undertaking, and the only railway at all available before Warsaw falls is the one through Kielce, and it reaches but one small part of the front to be attacked. With the fall of Warsaw and Lukow, at the railroad junction between Warsaw and Brest-Litovsk, two more railroads are available to Ivangorod. The total lack of railways in the eighty-mile section from the railroad through Jaroslov to the one through Lublin is a serious handicap to the German armies advancing on Warsaw. In fact, unless Ivangorod falls in the meantime, the German army on this front will be without rail communications until it reaches and captures Warsaw, a distance of nearly two hundred miles from the nearest Galician railroad. This might easily be a factor which would decide this campaign against the Germans.

The Russians are holding on tenaciously to the line of the Dniester River in the extreme south. Here we have seen splendid examples of the power and initiative of which the Russian army is capable. Time and again this part of the army has made brilliant and successful attacks, only to lose all that was gained because of reverses to the Russians elsewhere. The strong line of the Dniester is the natural resting place for the southern wing of the Russian army and may become the pivot on which the entire Russian line will swing in case it is forced to withdraw east of Warsaw to the line of the Bug River. This foothold near the Rumanian frontier is very important to Russia, and we may witness a continuation of the heavy fighting in this section. In the sixty miles between Stanislaw and the Russian frontier there are five parallel rivers running from north to south, each of which is available as a defensive line for the slowly retreating Russians.

To the north of Warsaw, Germany's activity has increased during the week, and it is quite probable that her forces in this region have been reinforced to such an extent that they will take an important part in the campaign against the Polish capital.

On the French and Italian battle fronts the honors of war have been about equally divided during the week and neither side has made material gains. The French have been more active, and in some way the Germans have found the strength to meet attack with counter-attack sufficient to leave the balance undisturbed.

The future still depends on the outcome of the Russian campaign, and at this time predictions as to what that will be are accompanied by greater uncertainty than ever.

Why Do Men Over Forty Break Down?

By Charles F. Bolduan, M. D.,

DIRECTOR BUREAU OF PUBLIC HEALTH EDUCATION OF THE DEPARTMENT OF HEALTH, CITY OF NEW YORK.

WHY do men over forty break down? An easy question, surely. Ask the prohibitionist reformer and learn that it is all due to alcohol. Or listen to a learned discourse on the chemistry of food by a food faddist and hear him indict denatured foods. The earnest member of the men's purity league is certain that immorality is the cause of it all; the legislators of several of our Western States lay the blame on the "deadly cigarette." And the harassed business man sitting in his club with a high-ball beside him and puffing at a black cigar assures you most emphatically that the rush of modern business life supplies the correct answer.

But you, my dear reader, are more critical, more alert. "Do men over forty really break down?" you ask. They do. Moreover, in contrast to the diversity of expert opinions expressed, for example, regarding the alleged increase in cancer, there is entire unanimity regarding the reality of this increased breaking down of men over forty. To cite only a single convincing statement, let me reproduce here a table compiled from the United States Census reports:

COMPARISON OF MORTALITY.

Age	Deaths per 1,000 males		Per Cent Increase or Decrease
	1900	1911	
Under 5	54.2	39.8	−26.57
5 — 9	4.7	3.4	−27.66
10 — 14	2.9	2.4	−17.24
15 — 19	4.9	3.7	−24.49
20 — 24	7.0	5.3	−24.29
25 — 34	8.3	6.7	−19.28
35 — 44	10.8	10.4	− 3.70
45 — 54	15.8	16.1	+ 1.90
55 — 64	28.9	30.9	+ 6.92
65 — 74	59.6	61.6	+ 3.36
75 and over	146.1	147.4	+ .89
All Ages.......	17.6	15.8	−10.23

We see then that men past the prime of life do not live as long now as they did some years ago, a most unpleasant discovery for those of us reaching middle life. Surprising, too, when we recall how generally death rates have been falling during the past twenty years. Have then our statisticians erred? Not so. A little study of the table will show that there has been an enormous saving of life in infancy and childhood. In fact what our health measures have thus far accomplished is to effect a remarkable saving of child life, bringing these children up to maturity and well into middle life, only to have them die off faster than did the previous generation at the same age.

This at once supplies a clue to the cause of the increased mortality at the higher age groups—many of the children's lives we are saving lack vital resistance; they constitute the weaker members of society and readily succumb to the diseases common in middle life. In this sense child welfare movements, to the extent that they reverse the Spartan principles of natural selection, tend to lower the vital resistance of the adult population. Therefore, one of the reasons why men over forty break down is because they recovered, in childhood, of marasmus or scarlet fever, or measles, or diphtheria, or some of the other common diseases of that period.

We can gain a further insight into the reasons why men over forty break down by examining into the prominent causes of death which carry them off at that time. Without citing the figures, I may say that this reveals a marked increase, in recent years, of deaths from heart disease, arterio-sclerosis, Bright's disease, and certain diseases of the nervous system.

These diseases are intimately related to one another, and have many causative factors in common. Among these the most important are over-indulgence in alcohol and tobacco, the poisons of syphilis, gout, rheumatism, and certain other diseases, over-eating, especially over-eating of meat, lead poisoning, muscular over-work, exposure to cold and wet, and exposure to great heat.

A number of factors combine to make it extremely difficult for health administrators to make headway against the enormous prevalence of these diseases. In the first place, the onset of the disease is very insidious, so that the disease usually becomes well established before it is recognized. In the second place, it is not easy to prove to the satisfaction of the patient, the causal relationship of the inciting factor, even when this is recognized by the physician. Thirdly, most of the cases above enumerated (alcohol, tobacco, over-eating, syphilis) are intimately associated with some form of indulgence of the appetites, and these are difficult to control.

At the present time the average death rate in the United States is about 14, i. e., fourteen out of every 1,000 persons die annually. The writer is convinced that if syphilis and alcohol could be entirely eliminated, the rate would at once fall to 12 or under.

Because of a false sense of propriety, very little is published in the lay press about syphilis. As a result very few laymen realize the enormous havoc wrought by this disease. Yet syphilis now infests at least ten per cent of our adult population, and leads to untold misery, sickness and death. It does much to crowd our hospitals for the insane and our homes for idiots and feeble-minded; twenty per cent of all patients admitted to Bellevue Hospital give a positive Wassermann reaction, i. e., are infected with syphilis. Yet in the face of this, very few newspapers call the disease by name, employing instead such circumlocutions as social disease, blood infection or some other meaningless term.

The evil effects of alcohol on the public health are too well known to need discussion. It is, unfortunately, impossible to secure any accurate statistics to measure the degree of this influence. Moreover, there is still considerable difference of opinion, even among competent physicians, as to the effect on the human system, of small amounts of alcohol taken in the form of light wines or beer. On the other hand, there is quite general agreement regarding the pernicious effect of the continued use, as a beverage, of distilled liquors.

I have already mentioned that the diseases playing so prominent a part in the mortality of men over forty, namely, heart disease, arterio-sclerosis, and Bright's disease, begin insidiously. It is important to remember, however, that a competent physician is able to recognize the signs long before your own attention may be aroused by the symptoms.

In this connection, the results recently obtained in the routine examination of the Department of Health of the city of New York may be of interest, especially since the average age of these employees, namely, 33½ years for the men and 32 years for the women, represents the period when preventive measures should be begun. Of the 700 employees, 20 or 2.8 per cent were overweight to such a degree as to menace their health; an abnormal high blood pressure with some albumen in the urine was found in 25 cases, or 3.5 per cent; some derangement of the heart of varying degrees of severity was found in 92 instances, or 13.2 per cent. Altogether the number of persons who needed either advice or treatment, or both, was 327, that is to say, 44 in every 100 had, without their knowledge, some vital physical defect which might have shortened their life, by a number of years, if it had remained undetected.

The lesson is plain. If you are nearing or past forty, and are wise, you will consult your physician once a year, submit yourself to a thorough examination (including that of the urine) and carefully follow the advice he gives you. Don't wait until *you* notice suspicious symptoms; that is usually too late.

In conclusion let me warn you of the dangers of over-eating. Most of us eat too much. We would do well to follow the advice of the great English physician, George Cheyne: "*Every wise man*, after *fifty*, ought to begin to lessen at least the quantity of his aliment, and if he would continue free of great and dangerous distempers and preserve his senses and faculties clear to the last, he ought every seven years to go on abating gradually and sensibly, and at last descend out of life as he ascended into it, even into the child's diet." In short, why do men over forty break down? Indulging their appetites!

Disk Talking Machine Records Made by Anyone

HERETOFORE it has been entirely impossible for the general public to make a disk talking machine record; it is true that through the cylinder graphophone a speech record could be made, but duplicates could not be had without repeating the recording process, and in many ways the cylinder process was unsatisfactory, especially for musical recording.

For the first time in history it is now possible for anyone to make a disk talking machine record. Such a record will play upon any standard disk talking machine. This is made possible through the Personal Record Department of one of the great companies, and these records are made at its recording laboratory in New York city by the same experts who have recorded the voices of the great grand opera artists and the great symphony orchestras.

Heretofore satisfactory results in disk record making have been possible only for those artists who were experienced in making these records, assisted by the experts in the talking machine company's laboratory. The process of recording has been so improved that expert operators can now guarantee a faithful reproduction on a disk talking machine record for anyone who wishes to make it.

These disk records are made from an original metal die or matrix so that it is possible to secure duplicates or additional copies of these records in the future, even hundreds of years hence.

United States Battleship "California" and Class

WITH the advent of the new class of United States dreadnoughts of which the "California" is the title ship, our battleships will take on a form which is unfamiliar to the public. This is due to the contour of the bow, which will be totally unlike anything seen on an armored ship of the United States since the creation of our new Navy began over thirty years ago. The bow with which we are all familiar curves gradually forward to be rounded below the waterline into the ram—this last being a weapon of offense, which the development of the modern tactics has shown to be useless.

The great punishing power and extreme penetrating range of modern naval ordnance have made it certain that one or the other of two contending ships will be so severely handled before it can get within ramming distance, that ramming, as part of the tactics of a modern sea fight, has ceased to be seriously considered. Hence the decision of our naval constructors to omit the ram altogether, and build our future battleships with the outwardly-curving stemhead and bows widely flaring above the waterline which characterize the clipper bow. Not only will deadweight be saved by this construction, but the turning ability of the ship will be somewhat improved, and the fuller lines above the waterline will give to the "California" and her sisters superior seagoing qualities when driving hard into a head sea.

The ships of the "California" class are enlarged "Oklahomas," of 4,500 tons greater displacement and mounting two additional 14-inch guns. The armor protection is somewhat heavier, and the protection against under-water attack has been amplified by the further extension of the subdivision and by the provision of improved anti-torpedo bulkheads, designed to localize the effect of the very heavy explosive charges carried in the head of the latest torpedoes.

The "California" has a long forecastle deck, which is carried aft to the main lattice mast. Forward on this deck are two turrets, each containing three 14-inch guns, those in the after turret firing above the roof of the foremost turret. On the main deck, aft are two three-gun turrets similarly disposed. This gives a concentration of six 14-inch guns ahead, six astern and a broadside fire of twelve 14-inch guns.

The three guns in each turret are mounted in a common sleeve, and are elevated, trained and fired as one gun. This arrangement greatly assists the spotter in locating the fall of the shots, and making the corrections necessary in the elevation. Moreover, the placing of three guns in one turret effects a valuable saving of weight.

An admirable feature of the "California" is the exceptional height at which the amidships battery of 5-inch torpedo-defense guns is carried. There are twenty-two of these guns, four mounted in casemates on the main deck forward, four in casemates on the gun deck aft, ten in a central battery on the forecastle or spar deck, and four at the corners of the boat deck above the central battery. This arrangement gives a concentration of eight 5-inch guns forward and aft, and of eleven on each broadside.

A notable feature in this ship is the unusual extent and the great weight and thickness of the armor protection, which is more complete than that of any ship under construction for other navies, at least so far as is known. The great displacement of these ships—32,000 tons—has made it possible to clothe them with armor far in excess of that carried by the ships designed eight or ten years ago. Thus, the waterline belt, with a maximum thickness of about 14 inches, is 17½ feet wide, and this armor extends eight feet below the waterline. The ship carries 16 inches of armor on the conning tower, and the port plates of the three-gun turrets are no less than 18 inches in thickness. Moreover, the whole side of the ship between the extreme turrets up to the main decks will be heavily armored, and with the side armor will be associated heavy transverse armor bulkheads and several horizontal armor decks.

The battery of water-tube, oil-fired boilers will be contained in a set of separate, heavily-bulkheaded boiler rooms, extending clear across the ship and served by a single smokestack of large diameter, the base of which will be protected by heavy inclined armor—this being done to protect the uptake against penetration by shell and prevent the furnace gases from passing into the 'tween decks, as happened with disastrous effect to some of the Russian ships in the battle of Tsushima.

The "California" is 600 feet long on the waterline, 624 feet in length on deck; her breadth is 97 feet, her draft 30 feet, and her displacement 32,000 tons. She will be provided with four submerged 21-inch torpedo tubes, and her complement will consist of 1,056 officers and men. Her contract speed is 21 knots.

The cost of the ship, exclusive of armor and guns, is $7,800,000, and when complete she will have cost over $15,000,000. She was laid down in February, 1913, and is due to be completed in February, 1916.

Railroads Under and Ov he

Blasting Tunnels Through the Rocks of Manhattan Difficult Operation of Peeling the Roof Off the Existing Subway

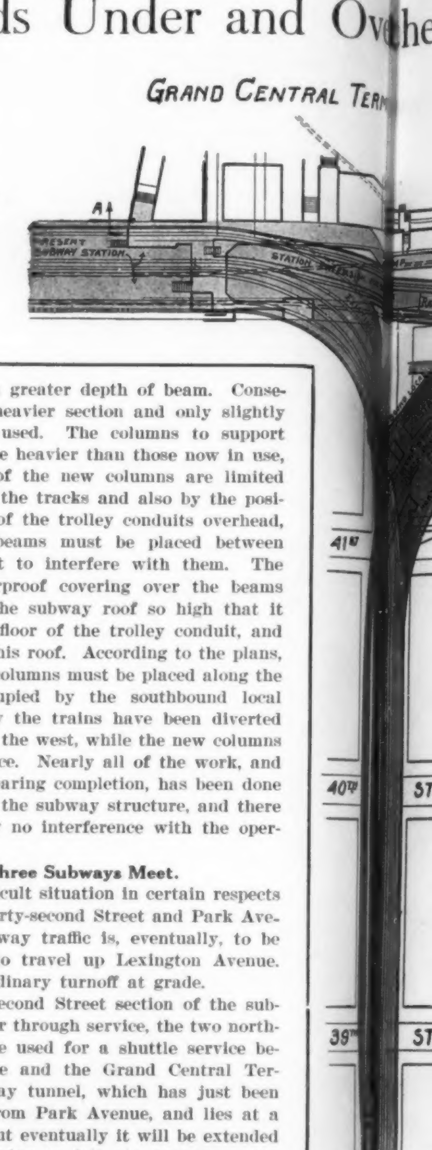
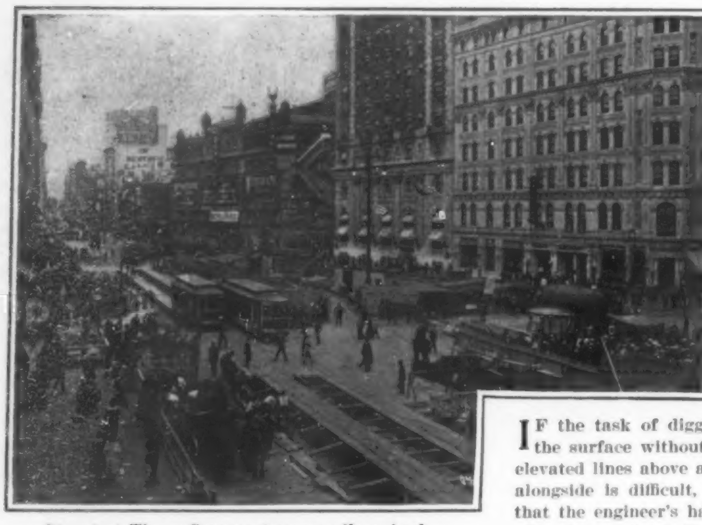


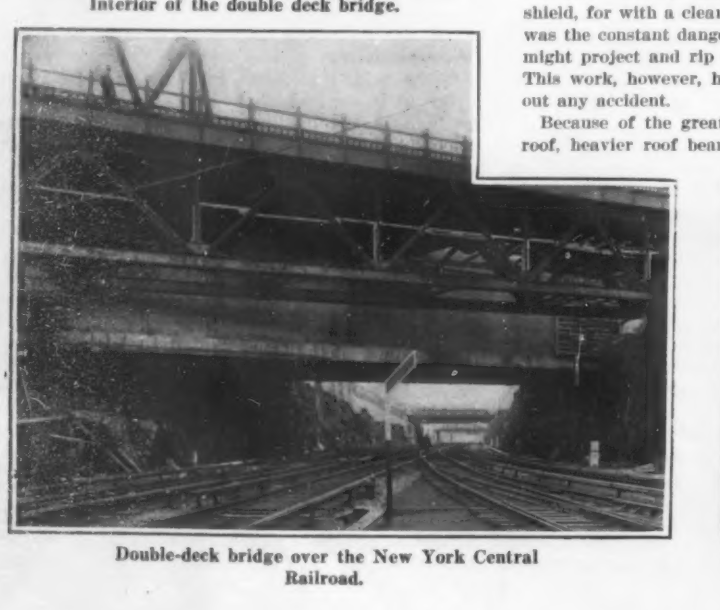
Fig. ...on at 4... Str...k Avenu



Street at Times Square, temporarily raised.

Deep rock cut on Mott Avenue.

Interior of the double deck bridge.



Double-deck bridge over the New York Central Railroad.

IF the task of digging out a subway close under the surface without disturbing traffic overhead or elevated lines above and the foundation of buildings alongside is difficult, it will be readily appreciated that the engineer's hardships are greatly multiplied when he must, at the same time, make connections with existing subway lines without interrupting the flow of the traffic over them.

Joining the New With the Old at Times Square.

As explained in our issue of July 10th, the existing subway running under upper Broadway, will be diverted from its present course across town at Forty-second Street and continue down Seventh Avenue. The new line is being grafted upon the old at Times Square. At this junction the roof of the subway must be redesigned so as to cover the diverging tracks. But the work is greatly hampered by lack of room between the street surface and the subway roof. The subway runs so close to the surface that there is only just room enough for the trolley conduits, and in some places the yokes of these conduits rest directly upon the roof.

In order to provide clearance for the workmen it was found advisable to raise the street level at this point about three feet. This was accomplished by laying an elevated timber decking with ramps leading from the present street surface up to the new level. Into the cramped quarters under this decking and through the usual tangle of pipes and conduits the workmen have crept and cut away the concrete arches of the present roof.

When the subway was first built, it was designed to provide a clearance of at least six inches between the tops of the cars and the bottom of the roof girders. But since that time the rail base has been raised two inches and in some places, owing to local conditions, there is actually a minimum clearance of only 2½ inches. With such a slight clearance, the difficulty of cutting away the concrete arches between the girders without disturbing traffic and dropping the broken concrete upon the tracks below may well be imagined. An ingenious form of shield was devised by Mr. G. H. Clark, Engineer of the contractor, which was fitted in the arches. This shield was held in place by means of rods with T-heads, the latter being slipped into slots and then turned at right angles so as to engage the shield and hold it in place. This shield was introduced into place from the outside of the subway structure, through a slot cut in the side wall. Then by means of block and tackle it was hauled the length of the arch, step by step, as the work of removing the arch proceeded. Of course, the suspension rods were keyed to prevent them from turning, and the greatest care was exercised to prevent sagging of the shield, for with a clearance of only 2½ inches, there was the constant danger that some part of the work might project and rip off the roof of a passing car. This work, however, has been completed now without any accident.

Because of the greater span required in the new roof, heavier roof beams must be used. But there is little room for a greater depth of beam. Consequently beams of heavier section and only slightly greater depth are used. The columns to support these beams must be heavier than those now in use, and the positions of the new columns are limited by the positions of the tracks and also by the positions of the yokes of the trolley conduits overhead, for the new roof-beams must be placed between yokes, in order not to interfere with them. The concrete and waterproof covering over the beams brings the top of the subway roof so high that it actually forms the floor of the trolley conduit, and the yokes cut into this roof. According to the plans, several of the new columns must be placed along the line originally occupied by the southbound local tracks, and recently the trains have been diverted over a new track to the west, while the new columns are being set in place. Nearly all of the work, and it is now rapidly nearing completion, has been done from the outside of the subway structure, and there has been practically no interference with the operation of trains.

Where Three Subways Meet.

An even more difficult situation in certain respects is to be found at Forty-second Street and Park Avenue, where the subway traffic is, eventually, to be diverted eastward to travel up Lexington Avenue. Here there is no ordinary turnoff at grade.

When the Forty-second Street section of the subway is abandoned for through service, the two northbound tracks will be used for a shuttle service between Times Square and the Grand Central Terminal. The Steinway tunnel, which has just been opened, runs east from Park Avenue, and lies at a much lower level; but eventually it will be extended to Times Square, rising to join the present southbound Forty-second Street tracks near Sixth Avenue, and Forty-second Street and Park Avenue will, therefore, be a most important junction for here three subway lines will meet and contact with the New York Central & Hudson River and the New York, New Haven & Hartford Railroads in the Grand Central Terminal. There is the further probability that still another subway will come in here for the Hudson & Manhattan Railroad Company holds a franchise for the extension of its line to Park Avenue and Forty-second Street.

The accompanying map will help to untangle the maze of traffic at this spot, showing also the loop of the Grand Central

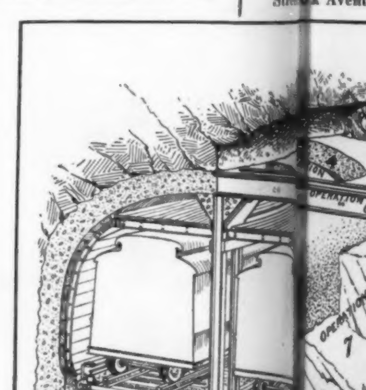
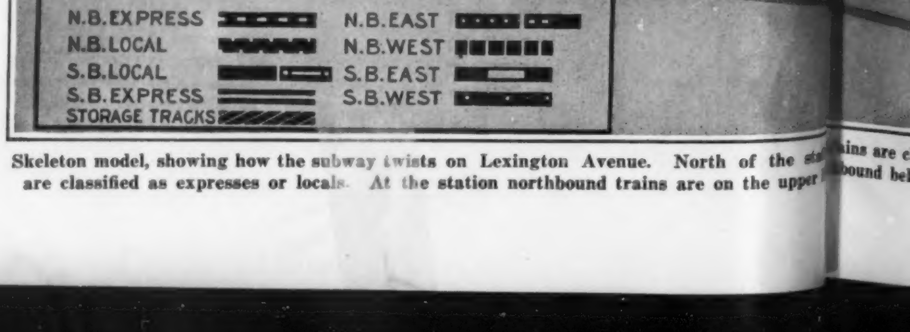


Fig. 2.—Method of un... old subw



Skeleton model, showing how the subway twists on Lexington Avenue. North of the sta... ains are c... are classified as expresses or locals. At the station northbound trains are on the upper ...bound be...

Ov he Streets of New York—II

The "Corkscrew" Construction Under Lexington Avenue Explained

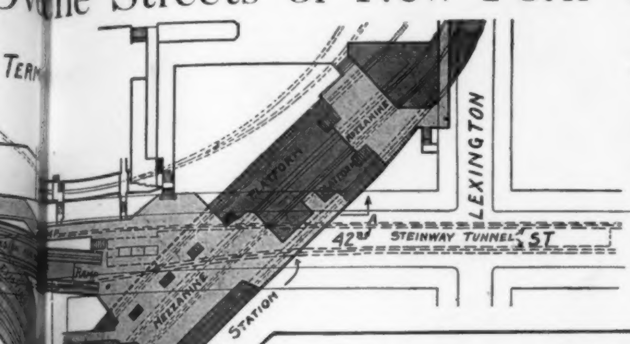
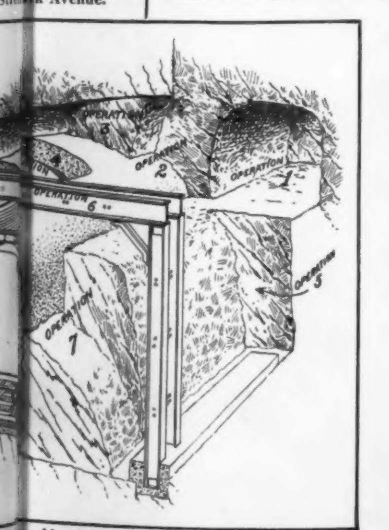


Fig. ...on at 42nd Stre... k Avenue.

Railway Terminal. To avoid congestion an elaborate system of platforms must be provided. As shown in the map, the present northbound station platform will be extended so that the shuttle trains will let off and take on passengers nearer the Grand Central Terminal, and also nearer the Lexington Avenue subway station or "Diagonal Station" as it is commonly called by the engineers, because of its position with respect to the streets. A broad mezzanine platform will be built over the latter station, connecting by a ramp with the end of the shuttle station platform. This will give access to all the tracks of the diagonal station, while a bank of elevators and a stairway will lead down to the station platform of the Steinway tunnels.

To the east of Park Avenue Forty-second Street runs on a downward grade, and in order to provide headroom for the mezzanine platform, the new station must be placed at a lower level than the present subway. Were the new station to be built on Forty-second Street, it would contain a double curve, one end running around from Lexington Avenue into Forty-second Street, and the other from Forty-second Street into Park Avenue. Fortunately, the city was able to acquire the property at the southeast corner of Forty-second Street and Park Avenue, where the Grand Union Hotel was formerly located, and to purchase an easement from the Grand Central Terminal property at the northwest corner of Lexington Avenue and Forty-second Street; so, instead of following the street line, the new subway will cut diagonally across from Forty-first Street to Forty-third Street and here there is ample room for a tangent station.

A grade connection with the existing subway is out of the question because it is impossible to reach the lower level in the short space between the present line and the end of the diagonal station. Instead the connection must be made several blocks farther south. The present subway consists of two double-track tunnels on one level, one taking southbound express and local trains, and the other northbound locals and expresses. When these subway tunnels were driven the tunnel on the eastern side of Park Avenue was moved well over toward the building line. This left a thick core of rock between the two bores. Now this core is being cut away so as to make connections between the express tracks of the new line and the express tracks of the existing line. Starting at about Thirty-ninth Street, the new express tracks will converge from the existing tracks, until they pass between them; then they will sink rapidly until they have gained sufficient headroom to pass under the existing subway and turn east into the Grand Union lot. The southbound local track of the new line will turn west from the present tracks at Thirty-eighth Street, and run under the sidewalk of Park Avenue until it has sunk to a sufficient grade to pass under the existing tracks. Unfortunately, there is not enough room under Park Avenue for the new northbound local track to turn off and clear the existing track south of Forty-first Street. It will be impossible for the track to sink to the level of the diagonal station after clearing the existing track, without taking too steep a grade, and so it will have to begin its downward incline *before* clearing the track. The existing track will have to be suspended and its bed and ballast removed, while a new track is built under it and run down to the proper grade. All this work must be done without disturbing traffic, so that some night when the new line is completed, the old tracks can be ripped up and trains can travel over the new line without any delay.



...old subway under Park Avenue.

Work in Treacherous Rock.

The work is made particularly hazardous by the treacherous character of the rock through which the tunnels must be cut. When the existing subway tunnel was run close to the eastern building line of Park Avenue, the nature of the rock was not so clearly understood and there were some slides. The rock of Manhattan Island, known as Manhattan schist, is made up of very hard material interspersed with large pockets of disintegrated rock. Furthermore, the rock is full of seams which dip generally to the westward, although this is not universally the case, for once in a while a seam is encountered which takes a dip in the opposite direction. The disintegrated rock is often so soft, that after exposure to the air for a short time it may be broken off with the fingers and pulverized in the hand. With rock of such a character it will be appreciated that the task of cutting away the core between the existing tubes is an extremely delicate one. These tunnels are formed with an arched roof, and it will be necessary to cut away one side of the arch. We must not forget that trains run through this section during the rush hours, under headway of a minute and a half, and even during the slack hours between 1 A. M. and 6 A. M., a local service of seven and one half minutes headway is maintained. There is little opportunity, therefore, to work from the existing tunnels. However, they are to be attacked from the outside and they have been lined with a timber shield to catch falling particles. A drift has been run from the Grand Union lot under the subway, and up through the core between the subway tunnels, and at present writing the task of breaking into the present subway tunnels is about

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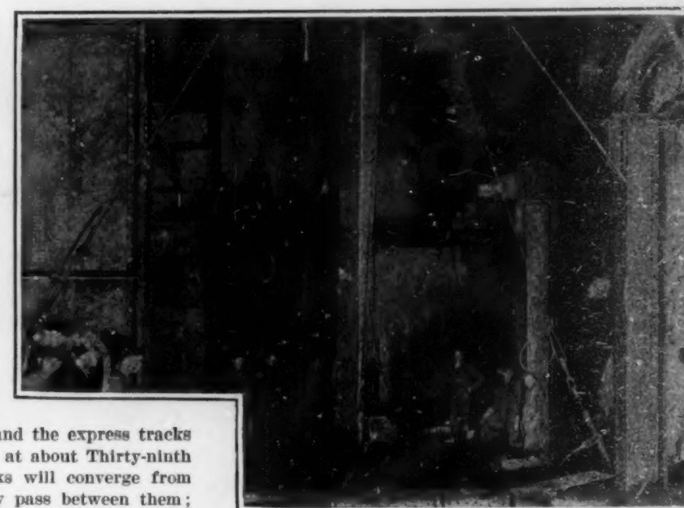
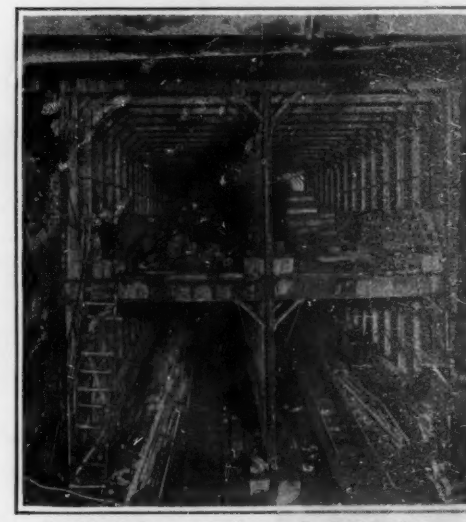
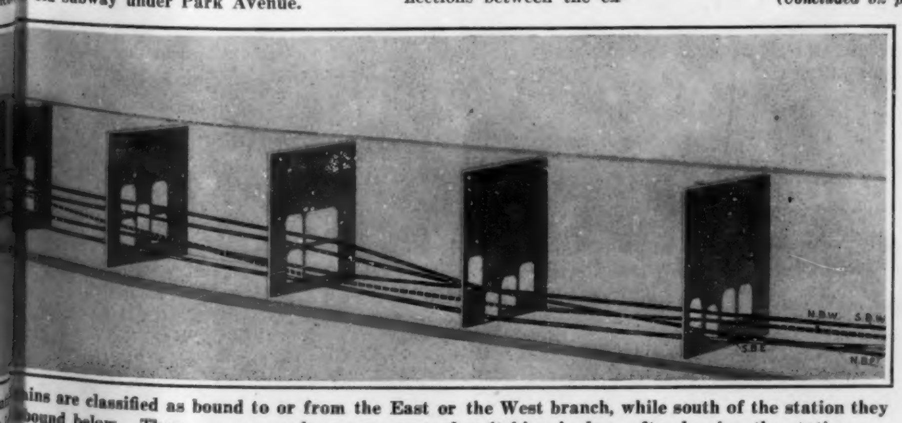


Steel work in the Steinway tunnel.

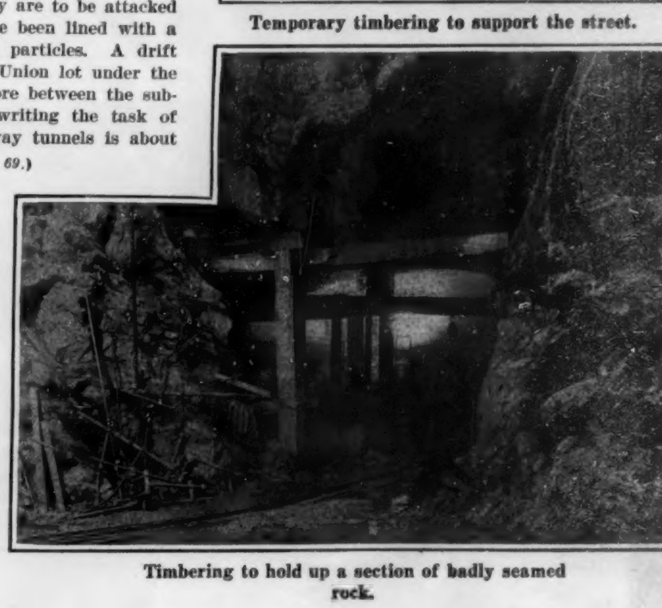


Double deck construction on Lexington Avenue.

Temporary timbering to support the street.



...ins are classified as bound to or from the East or the West branch, while south of the station they ...bound below. There are no grade crossovers and switching is done after leaving the station.



Timbering to hold up a section of badly seamed rock.

Even buggies cut deep ruts in soft roads.

A road badly cut up by horse-drawn wagons.

The Motor Truck and the Road

Who Should Pay the Road Tax?

By John S. Harwhite

THE quantity and quality of good roads have, generally speaking, kept pace with the increase in activity of the motor car. Good roads were practically unknown in this country before the advent of the automobile—not so much because they were impossible as because the limitations of speed and endurance of the horse rendered them unnecessary. Because, therefore, they have followed so closely the use of the motor car, the expenses necessary for the construction and repair of good roads have been popularly supposed to be the fault solely of the automobile—and laws have been made accordingly.

Shifting Tolls From the Horse To the Motor.

In fact, as taxes and license fees for the maintenance of good roads have been added to the burden of the motor car owner, the driver of the horse and wagon has been proportionately freed from this burden in many instances. Witness the number of toll roads, for the use of which the horse driver formerly paid so many cents per mile, and which have now been substituted by State-built highways that are open to the free use of any vehicle. But the owner of a motor car—whether it be a pleasure car or truck—pays a State license fee of from five to fifty dollars a year, while the owner of a horse-propelled vehicle goes scot free.

Any fair-minded and clear-thinking man will agree that the burden for the construction and upkeep of roads should be distributed in the proper proportion among those who derive the benefits from those roads, and based largely on the amount of destruction wrought by those vehicles which use the roads the most. To assume, then, that the wear of our roads is caused solely by the motor-driven vehicle, is to dispute the absolute evidences furnished both by theory and practice. Superficially, we may say that road wear has increased ten times since the advent of the motor car—but roads have been used more than ten times as much as was the case when the horse furnished the only means of highway transportation. It is in reality the wonderful increase in the *volume* of highway traffic that has blinded the average man to the facts and has led him to attribute rapid road deterioration solely to mechanical transportation.

Which makes the better road-cutter, the narrow steel tire or the broad rubber tire?

Effect of Speed on the Road Surface.

But we must admit that the motor car, aside from its great preponderance in numbers, is a serious offender so far as road wear is concerned because of the speed at which it travels. This factor is well cared for, however, if we include in our basis for uniform taxation of road vehicles the average distance covered per unit of time by the various types of road users; in other words, speed is an important consideration, not only from the standpoint of the greater distance covered but also because rapid travel over a given number of miles has a greater disintegrating effect on the road surface than the same mileage covered at a slower rate.

We, therefore, have the experimentally and theoretically sustained statement that, if a wagon and a motor truck, weighing the same and with the same size of wheels and width of tires, are driven at the same speed over a certain stretch of road, the greater wear will probably be caused by the horse-drawn vehicle—not only because of the action of the horses' hoofs, but because of the steel tires of the wheels.

The only basis of the present form of taxation is the horse-power, determined by multiplying the square of the bore of the motor by the number of cylinders, and dividing this product by 2.5. This gives a fairly accurate comparison of the horse-power of motors of different sizes, and is sufficient for all practical purposes of taxation (but not of actual horse-power rating). But under certain conditions, a two-horse team and wagon (which would not pay one cent of tax to the State) can cause more destructiveness to costly roads than any five-ton motor truck. In fact, it is stated on eminent authority that one of the least harmful appearing vehicles, the single-horse light runabout, can be the cause of more road wear than a heavily loaded touring car—and all because the weight of the first mentioned vehicle is concentrated on narrow steel tires that will cut into anything but the hardest road surface. It is, therefore, evident that only when it is considered in conjunction with other features of vehicle design and operation can horse-power be used as a basis for taxation.

Injury Done by Horses' Hoofs.

On a dry-surfaced road, the destructive effect of traffic is first caused by the loosening of the particles of the surface. A horse's hoofs, which are first sunk into the surface, and are then braced against the indentures thus made in order to obtain a sufficient "anchorage" to haul the load at each step, are especially destructive, and if these are followed by steel-tired wheels bearing a heavy load, the damage wrought is two-fold. A motor car, on the other hand, is propelled by its own rear wheels, but the action is more than a rolling one, for traction must be secured at the point of contact with the road surface, and the entire power of the motor must be concentrated at these two points. Thus the gripping to secure traction is combined with the rolling action of the rear wheels, and the tendency is to loosen particles of the road surface and to "kick" them out behind.

Aside from the greater reaction at the driving wheels caused by high speed, the ensuing suction and air currents whirl the dislodged particles in all directions, and eventually the road surface disappears entirely. This is an effect of high-speed travel that is often lost sight of by the average motorist, but it is sufficiently important to deserve inclusion in the consideration of taxable factors.

Weight and Area of Tire Contact.

Except as high speeds, heavy loads, and high powers must, as a rule, go hand in hand, the actual power which the motor is capable of developing plays a minor part in road wear—and yet at present it is the sole basis of taxation of automobiles. The weight of a vehicle under running conditions is one of the most important factors when considered in connection with other features of design. A load, the major portion of which is concentrated on the two rear wheels of the truck, will naturally wear a road much more rapidly than would be the case were the same weight more equally distributed on each of the four wheels. In like manner, a certain weight per wheel concentrated on a narrow tire will serve to cut and wear the road surface more rapidly than if a fifty per cent greater weight were carried on tires of double the width of the one in question. It therefore becomes a matter, not of weight alone, but rather of proportion of weight to area of tire contact. Weight in pounds per square inch of tire contact with the road is consequently the only manner in which load or weight need be considered. This can well be realized if we take the case of a steam roller; this is probably the heaviest type of road vehicle, and yet its action on the road surface is beneficial rather than harmful, for the wheels and rollers carrying the load are so broad and the weight is therefore distributed over so large an area, that the weight per square inch of road contact becomes scarcely greater than that of a bicycle and rider.

Steel vs. Rubber.

But the area of contact of the tire with the flat road surface is dependent upon more than the width of the tire and the diameter of the wheel. It is in this consideration that the *kind* of a tire—whether steel, solid rubber, or pneumatic—plays an important part. If the material of which the tread of the tire is constructed is hard and unyielding, the area of contact will be scarcely more than a line equal in length to the width of the tire in question. Rubber is more yielding, and as it flattens appreciably at its point of contact with the road, the area of contact becomes a true surface of two dimensions. Furthermore, the softer texture of the rubber serves to deaden, or cushion, the severity of

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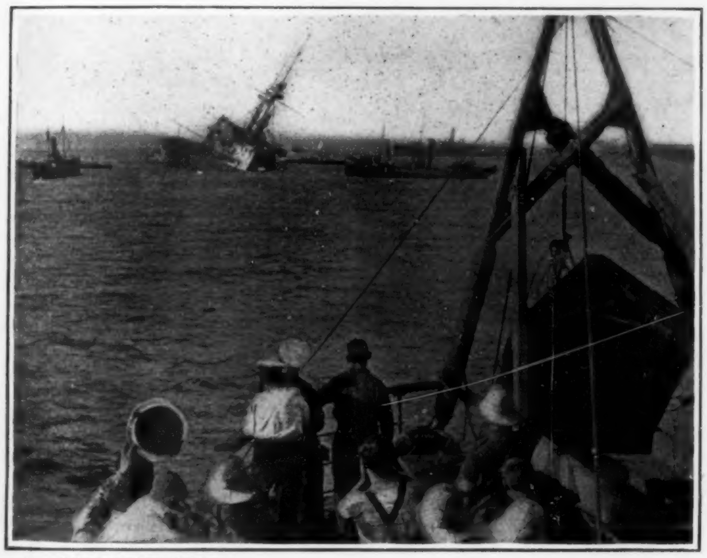
Copyright by Underwood & Underwood

A battery of heavy Russian field guns.

Copyright by International News Service

Austrian train decorated to escape detection by aeroplanes.



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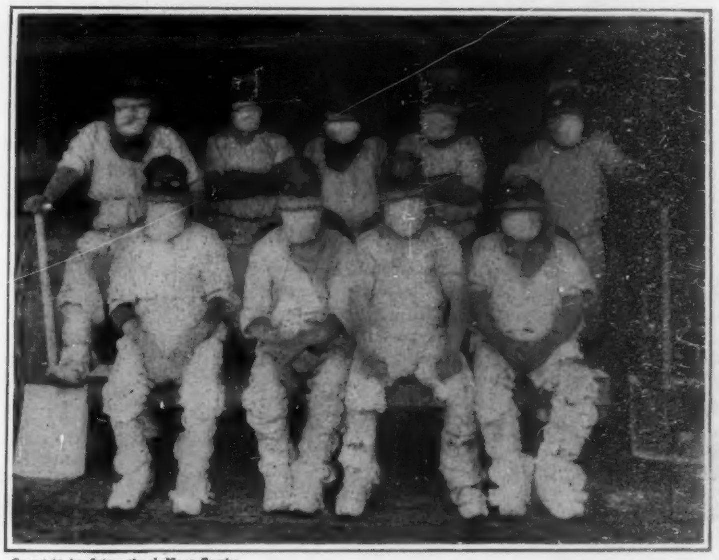
The British battleship "Majestic" heeling over after a submarine attack at the Dardanelles. Compare with picture below.



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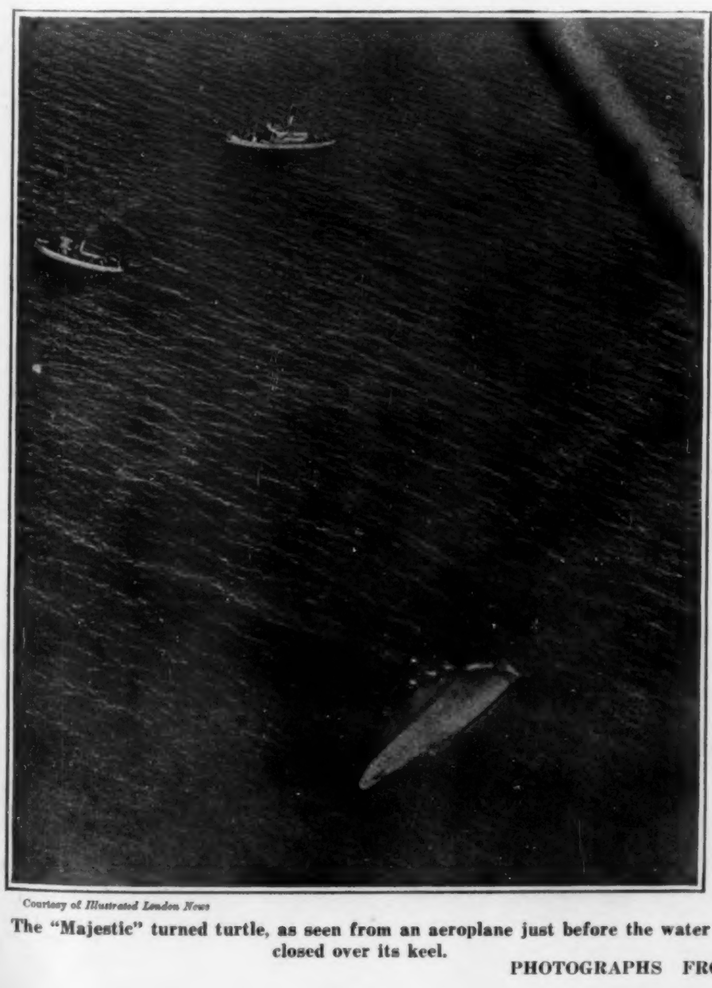
Not poison gas warriors, but bleaching powder packers armed against chlorine gas. They are now engaged on British government contracts.



Courtesy of *Illustrated London News*

The "Majestic" turned turtle, as seen from an aeroplane just before the water closed over its keel.

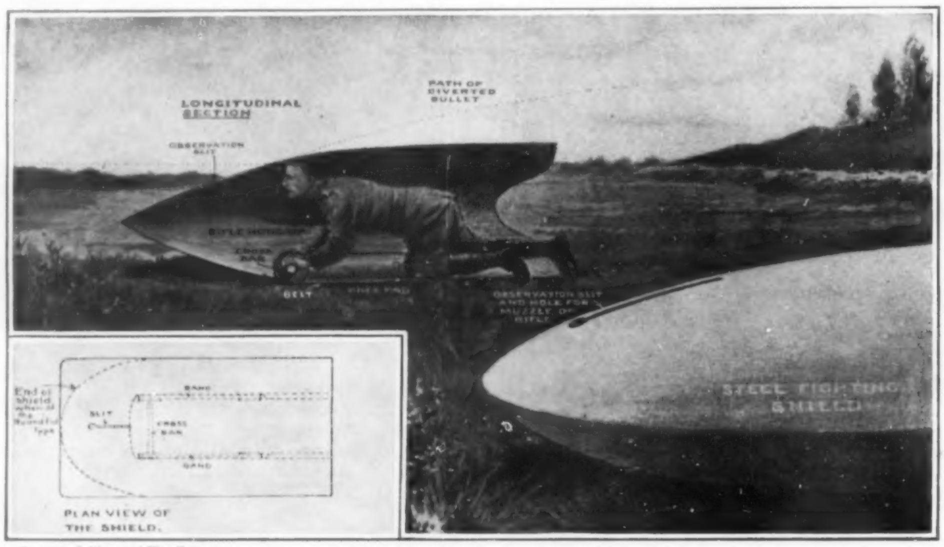
Copyright by International News Service

One of the famous 42-centimeter shells that failed to explode and was accepted as a trophy by the French.

PHOTOGRAPHS FROM THE WAR FRONT

Portable Shield for Soldiers

THE European conflict, and particularly the deadlock on the western frontier, has set inventors to devising means for overcoming the great defensive strength of trench warfare. Pictured herewith is a so-called "moving fort," designed by a British inventor, which is intended to afford shelter for an individual soldier when advancing on the enemy's entrenchments. It is a shield of tempered steel plates and weighs 200 pounds. This weight is reduced when the forward corners are rounded off. The steel-plating is arranged at a considerable angle to the line of fire. The advantage of this is that a greater effective sectional area is presented to the line of fire; also that the bullet will glance off the plating. Such shields will enable a troop to approach to, at least, within twenty yards of the enemy's trench in comparative safety. From that point of advance, they can fire into the enemy, or, if desirable, push still closer, or quit their shields and rush the short remaining distance. It will be understood, o' course, that the shield is moved forward by pushing against the ground with one foot.



Courtesy of *Illustrated War News.*

War shield to protect soldiers when attacking an intrenched enemy.

An Excavating Machine That Walks

A VERY curious machine has been developed in Chicago for land drainage work, which, instead of being mounted on wheels, is provided with a walking mechanism. Long ago it was recognized that wheels, even when very broad, do not have sufficient bearing surface for a heavy machine that is to be operated on soft ground, and, as a result, the caterpillar type of propulsion was developed. But it is claimed that in very soft ground the latter tears up the soil. To overcome this objection and produce a direct downward pressure upon the ground, the apparatus shown in the accompanying illustration was devised.

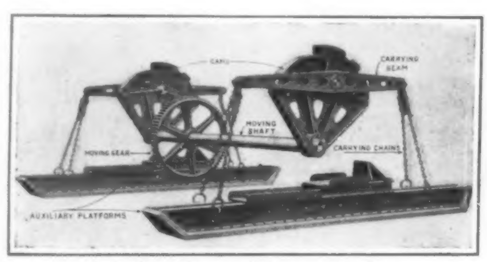
It consists of a central turntable, upon which the excavator normally rests, and two shoes, one at each side, which, when the machine is walking, alternate with the turntable in taking the weight of the machine. The excavator is arranged to turn on the turntable when the shoes or "auxiliary platforms," as they are called, are lifted off the ground, and in this way the machine is steered. It may change its direction readily to any desired angle.

The mechanism that operates the auxiliary platforms is shown in one of the illustrations. A cam shaft driven through step-down gearing from the main engine carries at each end a cam of the general form of a segment. Mounted on each cam is a carrying beam connected by chains to the auxiliary platform. Each cam is formed with lugs on its periphery, adapted to mesh with similar lugs on the auxiliary platform.

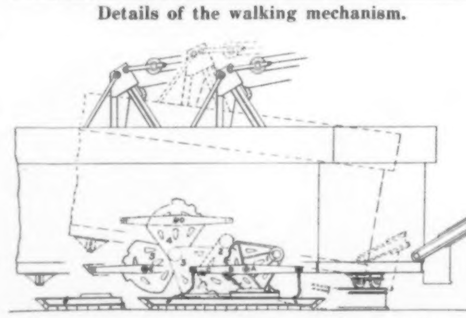
The line drawing shows the series of movements in one complete revolution of the cam shaft which are performed in taking a single step. The successive positions of the cam shown are numbered, while the positions of the center of the carrying beam are indicated by the letters *A* to *E*. In moving from position 1 to position 2, the cam lifts the turntabl and with it the entire machine off the ground, and the entire weight is taken by the two auxiliary platforms. Because of the intermeshing lugs of the cams and the platforms, the entire machine is moved forward from position 1 to position 3, whereupon the weight of the machine is taken by the central turntable again, and as the cam moves to positions 4 and 5, it lifts the auxiliary platform off the ground and moves it ahead, ready for the next step.

When the machine has walked to its work, the auxiliary platforms at each side are raised off the ground and locked in that position, after which the engine is disconnected from the walking mechanism and used for operating the excavating mechanism. The machine can then be swiveled about on the turntable, and as the work proceeds the walking mechanism can be put into operation to move the apparatus to a new position.

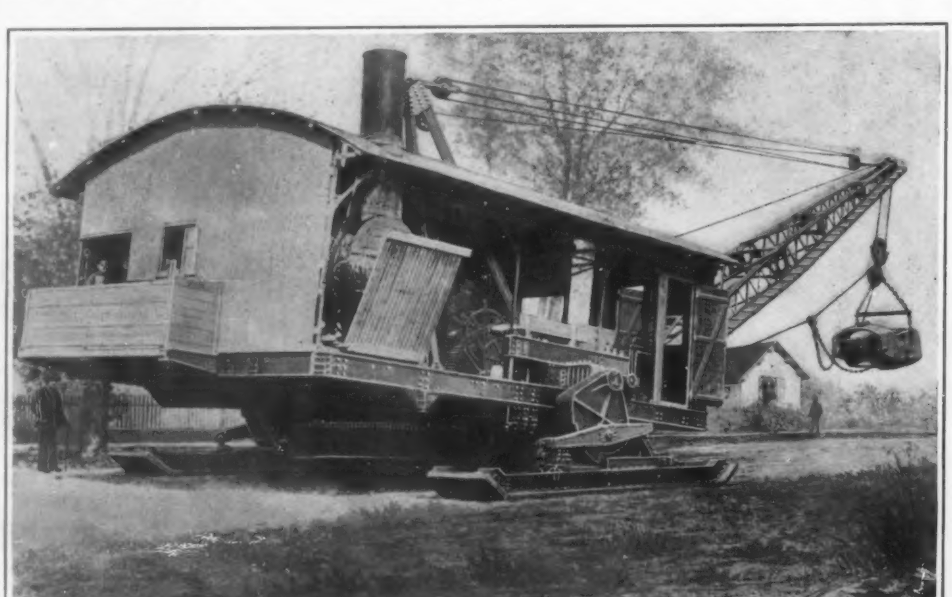
If the turntable or the shoes sink into the ground matters little, for when the machine walks it picks its feet off the ground and does not have to roll out of the hollow.



Details of the walking mechanism.



Successive positions of the mechanism in taking a step.



A walking excavator trudging through Naples, Ills., on its way to the work.

A New Galvanic Cell

ONE cause of the gradual weakening of the current of single-liquid galvanic cells is the electrolysis of the salt formed by combination of the liquid with the metal of the soluble electrode. In Volta's original cell, for example, the liquid ultimately becomes a solution of zinc sulphate, from which zinc is deposited on the copper electrode. The zinc thus deposited, however, is redissolved by local galvanic action between it and the copper. To insure constancy of the cell this deposition of zinc must be prevented. It cannot occur in two-liquid cells, because the zinc salt remains concentrated about the zinc electrode. In single-liquid cells, the obvious remedy is to substitute for zinc some metal that forms insoluble salts.

The *Revue des Sciences* describes a cell recently invented by Bellini, which uses lead instead of zinc, and which has a very low resistance, because the electrodes are very near each other and interlaced, as in storage batteries. In Bellini's first experiments the insoluble lead salt, sulphate or chloride, adhered to the lead electrode and made the resistance very high. A slight improvement was effected by adding nitric acid to the liquid. Finally, the lead electrode was replaced by an electrode of lead amalgam, from which the insoluble lead salt detaches itself and falls to the bottom of the vessel. The most suitable amalgam is composed of nine parts of lead and one part of mercury; a good formula for the liquid is 80 volumes of sulphuric acid of 66 Baumé, 120 volumes of nitric acid of 36 Baumé, and 1,000 volumes of water. In these conditions, with carbon as the other electrode, the electromotive force is 1.10 to 1.15 volt, increasing slightly at first and then diminishing uniformly as the liquid is exhausted. The curve of discharge is like that of a storage battery.

By occasionally adding fresh liquid and removing the heavy white powder which accumulates at the bottom, the action can be maintained as long as the plate of amalgam lasts. The consumption of amalgam is about five grammes per ampere hour. Very little is consumed on open circuit. The gas disengaged at the carbon electrode consists of nitrogen, with small quantities of oxygen and oxides of nitrogen. The cell appears well suited for small wireless stations and laboratories.

Anaglyphs

ANAGLYPHS are stereoscopic photographs which, instead of being printed side by side and viewed with a stereoscope, are printed (or projected on a screen) in different colors in the same s'ace, and are viewed with eyeglasses of corresponding colors, so that the right eye sees one picture and the left eye sees the other. Thus the stereoscopic effect can be presented simultaneously to all the members of a lecture class, if each is provided with a pair of colored glasses. Red and green are the usual colors, but red and blue are preferable in some cases. The eyeglasses are of plane glass, coated with colored gelatine. A red picture printed or projected on white is quite invisible through a red glass of the proper tint, but this result cannot be accomplished perfectly with green or blue. Hence, the "green" eye not only sees the red picture, but it receives a faint impression of the green picture. In some cases this produces confusion, which, however, may be practically eliminated by making the red picture much stronger than the other. An error of 1-16 inch in the superposition of the pictures is of no consequence. Anaglyphs are very useful in illustrating machinery.

Effect of Pressure on the Diver

(Concluded from page 61.)

the man out of the more dangerous pressure zone below.

Were he brought up slowly from 175 feet, as was so long the practice, the greater pressure and the length of his time in it would have driven the nitrogen deeper into his tissues and thus increased the measure of his saturation. From 70 feet up, the period of decompression can be abridged by 10-foot stages of ascent, and these concluding steps or pauses are lengthened as the surface is neared—the longest halt being the last one below the surface when the final surcharge of nitrogen is brought into the general circulation and carried out of the body with the breath. When Crilley's associate, Drellishak, led the way in this deep-water work, by going down to a depth of 274 feet, he was held, when ascending, at ten feet below the surface for more than an hour. In this manner, recourse to the recompression chamber was obviated.

But so eminent an authority as William Wallace Wotherspoon, who had charge of the salvage operations on the "Empress of Ireland," where his men worked 160 feet down in very cold water, believes that a distinct advance can be made in the art by bringing the men to the 10-foot depth as now, but then to take them out of the water and to put them into the recompression chamber for decompression—thus avoiding the long suspension in the water near the surface, which must sap the vitality. He logically believes it is better to place the men in the chamber, where they can rest after getting out of their diving dress and damp garb, and, if necessary, be given something warm to drink. A sudden squall would endanger the life of a diver hanging overboard from a vessel a short distance below the surface, and practical commercial reasons would argue in favor of substituting the recompression chamber for a prolonged halt at the final stage of ascent.

Despite the extraordinary work of Crilley and his companions at Honolulu, a word of warning is due to those who prophesy that divers will soon be able to go still deeper. It must be remembered that compressed air means compressed oxygen as well, and oxygen highly concentrated in this fashion becomes a pronounced irritant when inhaled for a considerable period. Crilley, himself, developed pneumonia shortly after his last submergence, and the condition of his lungs since has been of a grave character. Indeed, he is to-day well nigh a physical wreck. While science has made it possible for the human body to battle successfully with the heavy pressures of deep submergence, it has not done away with the chemical problems that must of necessity persist. An excess of oxygen will inflame the lungs when exposure exceeds certain physical powers of endurance. In this, we see one more barrier that nature interposes to man's penetrating farther into the ocean's depths for the treasures hidden there or for the immediate salvage of some foundered craft.

Railroads Over and Under the Streets of New York—II

(Continued from page 65.)

to begin. It is only by nibbling tactics that the work can be carried on, for every precaution is being taken to protect the existing subway.

Uncovering the Existing Subway.

A very ingenious plan of procedure has been worked out by Mr. Robert A. Shailer, Tunnel Engineer for the contractor, which is illustrated in Fig. 2. It shows the operations as they will probably be performed and the order in which they will be carried out. As explained above, a shield has already been placed in each tunnel. First a drift (operation No. 1) is carried along the existing subway tube well above the spring line of the arch, so as to leave a bench of rock to take the thrust of the arch. From this drift the work proceeds laterally, the rock being removed from the roof of the tunnel as indicated by operations 2 and 3. Our drawing is a view looking south, and hence represents operations on the easterly tube where the direction of the seams in the rock is such as to produce a thrust toward the uncovered side of the tube. This work will be very precarious and can be carried out only in a small section at a time. By means of a telephone connection with a watchman stationed in the subway, the blasts will be timed to take place when no trains are passing.

Having bared the tunnel roof, the next operation is to cut into it, as indicated by operation 4. Material that falls from the roof will be caught by the wooden shield beneath. Because of the lateral thrust produced by the seamy rock, it will not be safe to cut away the entire roof at a single operation, but small openings will be made in it at intervals through which roof beams may be inserted and abutted against the farther half of the arch. The latter will be left standing and will form a part of the permanent roof structure.

Operation 5 consists in cutting away the bench of rock down to sub-grade and putting in a good foundation for the roof columns, while operation 6 consists in putting in the roof beams in pairs, 3 feet apart, and then concreting between them to form a section of the roof and side walls. In our drawing the rock on the right-hand side has been cut away by the artist so as to show the various operations. As a matter of fact the roof beams will extend to the rock on the right-hand side of the cutting and will be wedged against it so as to take the lateral thrust. After two pairs of roof beams have been set in place, the portion of the arch between them will be removed and replaced with the new roof construction. Where they meet the arch the roof beams will be temporarily supported upon the timber shield, while operation 7 is going on, the latter being that of removing the bench of rock and the side wall of the existing subway structure.

Operation 8, which is not marked in the drawing, consists in replacing the timber supports for the roof beams with steel columns placed between the tracks. In the existing structure a set of ducts is located between the tracks and under that is a drainage pipe. As this construction would not afford a sufficiently solid foundation for the columns, the ducts will be removed, and in their place will be a solid concrete foundation in which a pair of I-beams are embedded. This work inside the tunnel will be particularly tedious because of interruptions by passing trains.

Where the new express tracks sink between and pass under the present subway line, it will be necessary to expose the entire subway structure and reconstruct it so that the old line can bridge over the new with a minimum of clearance. For this purpose the street at that point has been replaced with a timber decking and is supported on girders. Suspended from these girders by means of rods passing through holes in the roof of the existing tunnel there will be shields to prevent falling masses from obstructing traffic below. With these shields in place, the tunnel roof will be taken away as will also the side walls and a new structure will here be built to conform with the new design.

A Double-decked Subway.

In order to provide sufficiently wide platforms and stations without taking over private property and without interfering with basement structures along the line, a large part of the Lexington Avenue subway is double decked, the express trains taking the lower level and the locals the upper level. In places the levels are so close that a singe deep excavation suffices, while in other places the tunnels are separated by a thick partition of rock; for the local track must follow the street surface to a certain extent, so that the stations will not be far below ground. Starting at Forty-fourth Street we find this two-level construction continuing to 102nd Street, beyond which for a space all four tracks are on a single plane. But at about 112th Street, the two-level construction begins again, continuing past the 125th Street express station and on to 131st Street, where we find them all again at practically the same level preparatory to taking the dip under the Harlem River in the four-track tunnel that has been constructed there.

A Tangle of Track Lines on Lexington Avenue.

Between 118th Street and 131st Street, the subway twists in a most amazing manner, which cannot be understood without some study. We have endeavored to make this clear by preparing a skeleton model of the section, and showing the various tracks by lines differently marked, so that they can be followed readily. In order to understand the drawing we must first seek the reason for this bewildering tangle. Starting at 118th Street the tracks are on two levels, the local trains occupying the upper tracks and the express trains the lower ones. It was not considered advisable to bring them into the 125th Street station in this way for the following reasons: In the morning the bulk of passenger travel will run south to the business section of the city and at night the tide will flow north. In other words, in the morning the bulk of the passengers will be entering the station and in the evening they will be leaving it. Passengers will not mind walking down two flights of stairs to reach their trains. But if the northbound expresses came in at the lower level in the evening, the crowds of passengers would find it a great hardship to have to climb up two flights of stairs to the street. For this reason it was decided to place all southbound trains, whether express or local, on the lower level and northbound trains on the upper level.

Referring now to our skeleton model, we can readily see that the northbound local track, which is on the east side at 118th Street, shifts westward and enters the station at the west side of the central platform, while the northbound express climbs steadily until it reaches the upper level on the east side of the station platform. Of course, to permit this shifting of tracks the southbound local and express train must be depressed, but we need not consider them just now. The northbound trains come into the station without any switching. But after they pass the station, they are routed according as to whether they are to take the Jerome Avenue line after passing under the Harlem River or the Westchester Avenue line, the former being a branch to the west and the latter a branch to the east. The switches are set while the trains are standing in the station. Locals or expresses that are to run to the east branch are switched to a central or third track that runs eventually to the extreme eastern side of the system. Trains that are to take the western branch continue on their own side of the subway, whether local or express, until this central track is cleared. Then the local and express tracks merge into one, which takes its proper place on the western side of the system.

Considering now the southbound trains, we find that they come into the station at 125th Street without any switching, the trains from the western branch being on the west side of the station and those of the eastern branch on the east side of the station, but after passing the station the expresses must be separated from the local trains. The express trains are switched to a common central track which eventually finds itself on the lower level and western side of the structure, while the southbound locals come from the east and west sides of the station and climb to the upper level, eventually coming together at about 118th Street on the upper west side. By means of this apparently complicated structure grade crossings are avoided and all the switching for trains is done while the trains are taking on or letting off passengers in the station.

After passing the Harlem River the western branch of the new subway runs under the main line of the New York Central & Hudson River Railroad and then crosses over the existing subway at the Mott Avenue station. Here the high arch of the station has been cut away and the new line sandwiched between the existing subway and the street above. A little

INQUIRIES

Inquiry No. 9444. Wanted the name and address of a manufacturer or patentee of a glass preserving jar made for use with air pumps for creating a vacuum.

Inquiry No. 9445. Wanted the name and address of a manufacturer who can make a combination pencil holder and point protector.

Inquiry No. 9446. Wanted the name and address of a manufacturer who can supply machinery for automatically wrapping cigars in thin imported tissue paper having the ends tightly wound and curled. Would consider purchase of machines or patent rights.

Inquiry No. 9447. Wanted to buy patented article, which is needed in every home, with a possible view to manufacturing and distributing.

Inquiry No. 9448. Wanted to get in touch with manufacturers who can make small gasoline motors and parts thereof. Must be able to handle considerable orders with expedition.

Inquiry No. 9449. Wanted the name and address of a manufacturer who is prepared to build a new and very simple stationary engine with or without gas producer.

Inquiry No. 9450. Wanted the name and address of a manufacturer who can build a light simple motor for light automobiles and for portable farm work.

Inquiry No. 9451. Wanted the name and address of a manufacturer of machinery for making egg albumen.

farther on there is a double-deck bridge over the Hudson Division of the New York Central Railroad. The upper deck carries the street traffic and the lower deck, which is slightly skewed with respect to the upper one, carries the subway. This deck is inclosed to keep out the smoke and gases of passing locomotives.

(To be continued.)

The Motor Truck and the Road

(Continued from page 66.)

the blows which are always struck on a road surface and which are due to even the slightest inequalities. A pneumatic tire is more resilient than is one of solid rubber, the flattened surface is, therefore, greater, and the weight per square inch of contact for loads of a given size is consequently less.

As motor vehicle tires are always of rubber, and as their width is generally greater than is that of the steel tires of horse-drawn vehicles carrying equal loads, we find a double reason why, upon these considerations alone, horses and wagons damage road surfaces more seriously than do motor cars. As it would prove to be an impossible undertaking to attempt to measure the actual area of road contact of every vehicle, it is probable that a certain constant will be adopted for each class of tire, so that this figure, when introduced into the formula taking into account the width of the tire, its diameter, and the total load on the wheel, will give approximate results for determining the road destructiveness of any wheel at a given speed.

Banking Roads to Prevent Skidding.

There is one important factor affecting road wear that we have not as yet considered, and one in which the motor car is by far the more serious offender. This is tire slipping and skidding—skidding being generally understood to mean a side slip, while slipping wheels indicate a loss of traction in a forward direction. Skidding is primarily dependent upon speed, although nature of road surface, tire surface, and "suddenness" of the turn play an important part. Slipping is solely dependent upon the nature of road and tire surfaces and the amount of acceleration. Skidding plays its most destructive part on winding roads that are not properly banked, while the results of slipping are seen most frequently at the beginning of hills or at other portions of the road where natural or artificial obstacles make it necessary for the majority of cars to shift to a lower gear.

Whenever a moving body is turned aside from its natural direction, there is a tendency for the wheels to continue in that direction because of the physical law relating to mass and velocity and the effort required to divert a moving body from a straight line. The greater the adhesion between the tire and the road, the greater is the tearing effort applied to the road surface. Therefore, even though skidding does not actually take place, the effect of diverting the heavy and rapidly-moving mass from its original direction is evidenced at all sharp turns. Where the road surface is loose, its top will be thrown aside in wide paths, due to the side-sweep of the wheels and the greater width covered by the treads because they are following the path of an arc rather than that of a straight line. The effect of a properly banked curve is to assist the change in direction of the car, and therefore roads scientifically constructed will not show the undue wear on the turns that is the case with "flat" corners.

Slipping on Application of the Brake.

The slipping of a tire at high speeds of travel might not be perceptible, but experiments have shown that, even on a hard, dry surface, this amounts to some four or five per cent at rates of travel exceeding forty miles per hour. But it is the slippage of the rear wheels due to the sudden application of increased power that is the most destructive type on road surfaces. This is primarily dependent on power and gear ratio. It has, therefore, been decided by those experts who are endeavoring to reach a satisfactory method of equable taxation for all road ve-

hicles, that the gear ratio of the direct drive, when properly introduced into the formula that must eventually be evolved, is one of the most necessary considerations. The others are those that have already been mentioned, viz., horse-power, speed, weight per square inch of tire contact, and the type of tires employed.

This is the motor car taxation situation as it stands to-day: The various prominent automobile bodies, such as the Society of Automobile Engineers, the National Automobile Chamber of Commerce, and the American Automobile Association, are endeavoring, not only to secure fair legislation, but also to arrive at some basis of equable taxation that can be adopted by the different States, so that there will be uniform laws prevailing throughout the country. Why should the owner of a motor truck, for example, who delivers goods across the boundaries of two or three different States, be subject to the exactions of as many different ways affecting the taxation of his vehicle? Work along these lines is still in its formative period, but with these prominent engineers and business men earnestly at work, our legislators must soon become interested and aroused to the unfairness of taxation laws that place a premium on antiquated hauling methods and that do not take into consideration the comparative cost of road upkeep entailed by the use of the different classes of road vehicles.

The Current Supplement

THE current issue of the SCIENTIFIC AMERICAN SUPPLEMENT is one of unusual diversity in the subjects treated, but at the same time the articles are of a character that will please every reader. Everyone has heard of chicory coffee—and it is by no means bad when intelligently made, but few know what chicory is, or how it is prepared. The growing and manufacture of chicory is a Franco-Belgian industry that has been seriously interrupted by the war, and an excellent description, extensively illustrated, is given of the methods of manufacture. Economy in Study gives valuable psychological and physiological points on how to study to the best advantage. Amateur enthusiasts in the art of wireless telegraphy frequently have difficulty in procuring a powerful and efficient source of current. An article in this issue gives one excellent solution of the problem. How many people can explain a thunderstorm? The older theories have become obsolete, while the accounts of modern theories are so scattered as to be available only with difficulty. The article on this timely subject gives the latest authoritative explanations and facts, and will be of universal value and interest. The relations of geographic influence on sociology, biology, and climatology are entertainingly discussed in an article on Problems of Geographic Influence. One of the greatest problems that is facing every technical man and manufacturer is the more economical use of fuel. The percentage of the power contained in coal that is delivered in useful power is disgracefully small, and the actually slight advances that have been made in this direction are surprising when compared to improvements generally. Some features relating to the recovery of by-products when producing power are discussed in the current issue of the SUPPLEMENT. Recent Progress in Astrophysics is a valuable review of a most important and interesting branch of science, and contains much recent information. Lime is such a common and cheap material that most people give it very little thought, and, indeed, probably consider it of little use except for covering walls. The technical and chemical applications of lime are surprisingly numerous, and it is its very cheapness and the readiness with which it can be obtained that make it the widest used and most economical chemical base. Something of these uses is told in an article reviewing the subject. Other interesting articles deal with gun-primers and detonators; the power of the telescope; the Use of Electricity in Ships for Operating the Auxiliaries; Making Munitions of War in England, and Elements With Several Atomic Weights.